



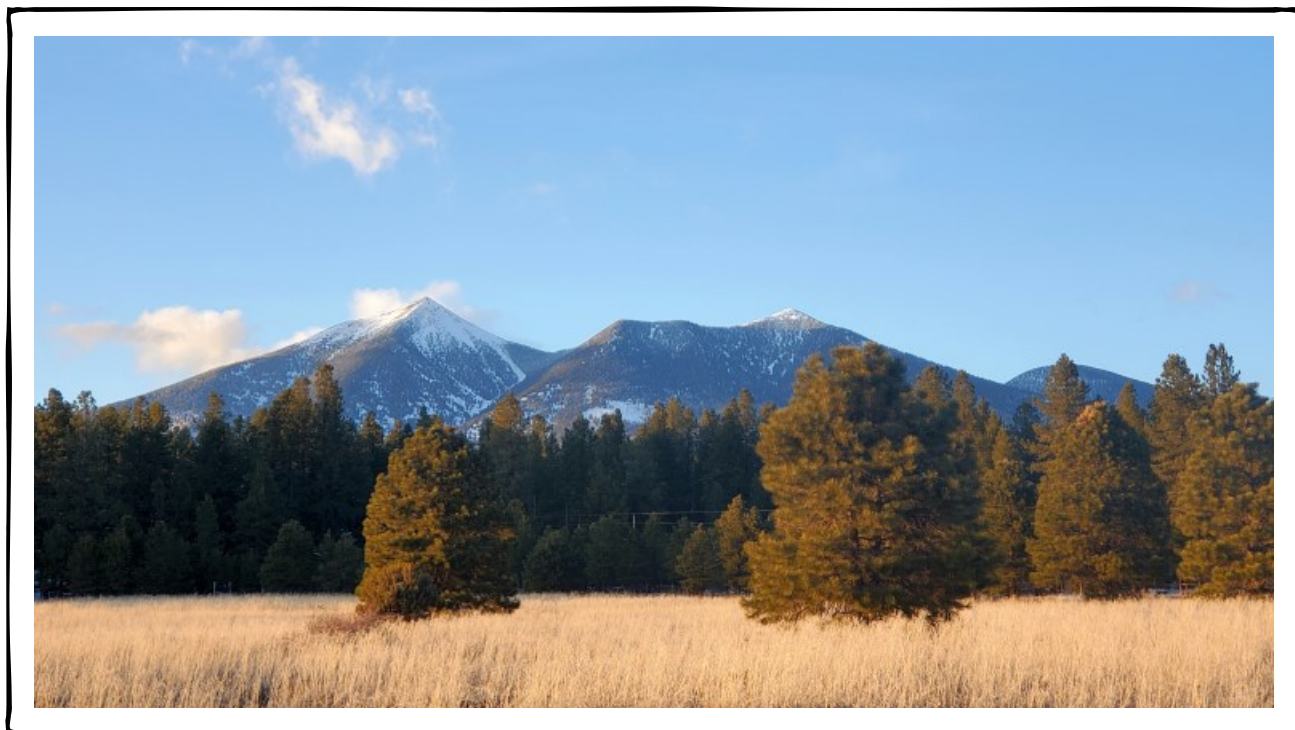
2021 REPORT TO THE WATER COMMISSION

Activities of Calendar Year 2020

CITY OF FLAGSTAFF WATER SERVICES DIVISION

**WATER, WASTEWATER, REUSE AND
STORMWATER**

Annual Report



Snow covers Agassiz, Fremont and Doyle Peaks. Photo by Joelle Sawaya



REPORT TO THE WATER COMMISSION

INFORMATION YEAR 2020

WATER, WASTEWATER, REUSE and STORMWATER ANNUAL REPORT

Including Historical Data &
Graphical Trends
July 2, 2021

**CITY OF FLAGSTAFF
WATER SERVICES DIVISION
2323 N. Walgreens Street, Suite 1
Flagstaff, AZ 86004**



**FLAGSTAFF
WATER
SERVICES**
We are Water



Water Services Staff Retreat, May, 2021



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2021 Water Commission

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Malcolm Alter
Timothy Bowers
Elizabeth Christy

Executive Members

[VACANT]
Chair

Ward Davis
Vice Chair

Commission Liaisons

Marie Jones
P & Z Representative

Miranda Sweet
Council Representative

Staff Contributions

To acknowledge those responsible for providing data and assembling the 2021 Annual Report to the Water Commission

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Interim Water Services Director
Water Resources Manager

1

ADMINISTRATION

Water Services is responsible for water production and distribution, wastewater collection and treatment, reclaimed water distribution, and stormwater management. The Division is also responsible for water resource management, water conservation, engineering, and regulatory compliance programming. This report provides an annual summary of operations, planning, and programming and is distributed throughout the year in response to various requests for information on the Water Services Division's programs. Water Services provides Master Planning documents for Water Policies, Water Resources, Infrastructure, SCADA, and Solids Handling. These documents can be found at the Water Services website at www.flagstaff.az.gov/waterservices.

MISSION STATEMENT OF THE WATER SERVICES DIVISION:

"Professionally and cost effectively providing water, wastewater and stormwater services that meet the present and future environmental, health, and safety needs of the community and our co-workers. Committed to a goal of 100% customer satisfaction achieved by a dedication to exceed customer expectations by continuously improving our operations."

1-1 A Message From Erin Young, R.G., Interim Water Services Director

As we come into Fiscal Year 2022, there is light emerging from the darkness of the pandemic. Through thoughtful and careful City leadership, Team Flagstaff persevered. We rose to the challenges of remote work, remote meetings, and adapting to new safety protocols while providing essential staffing at the plants, responding to waterline breaks and leaks, advancing technology for our staff. We replaced aging infrastructure, maintained communications with the public, planned for our water future, and mitigated the risks of flooding; we stayed busy in 2020!



In terms of highlights for the year, I would be remiss to not begin with acknowledging the dedication of our frontline workers during the pandemic. In 2020, our staff in Water Services found themselves adapting and developing protocols to safely maintain the most essential services to our community. As stated in a EPA press release on March 27, 2020: "Having fully operational drinking water and wastewater services is critical to containing COVID-19 and protecting Americans from other public health risks. Our nation's water and wastewater employees are everyday heroes who are on the frontline of protecting human health and the environment every single day." Each and every one of our operations and maintenance staff at the frontline has my utmost respect for their teamwork, knowledge, commitment. Thank you for your service to our community.

Other successes did not go unnoticed in 2020. A joint Management Services-Water Services partnership was recognized with a City Manager Award to our Customer Service, Billing/Collections, and Meter Services teams (page 69). Water Services received Gold status on the Alliance for Water Efficiency Leaderboard and our Water Conservation Program received an Excellence Award from the Environmental Protection Agency for WaterSense Promotions (pages 3 and 44). We are a team of excellence!

Some notable achievements through City Council in the last year include important revisions to Flagstaff's City Code for the Industrial Pretreatment, Fats-Oils-Grease, and Cross-Connection programs (page 64), adoption of the Water Conservation Strategic Plan in December, 2020 (page 46), and adoption of long-awaited merit increases and Pay Plan restructuring as investments in Team Flagstaff.

Lastly, Water Services continues a trend of drinking water compliance with its annual Consumer Confidence Report (page 63), continuous and regular communications (page 11), replacement of aging water and sewer lines (pages 8 & 9), SCADA/IS improvements, and community protections and preparedness from our Stormwater team (page 56), among many other accomplishments in the 2020 Annual Report to the Water Commission.

It is an honor to serve Team Flagstaff and our community in the capacity of Interim Director —Erin

1-2 2020—Planning for the Next Decade

2025 Water Services Strategic Plan

Water Services released the 2025 Strategic Plan, identifying the major issues facing the Division and the Flagstaff community over the next five years. Ten strategic objectives provide a basis for further dialogue regarding risks, needed investments, and opportunities related to water issues.

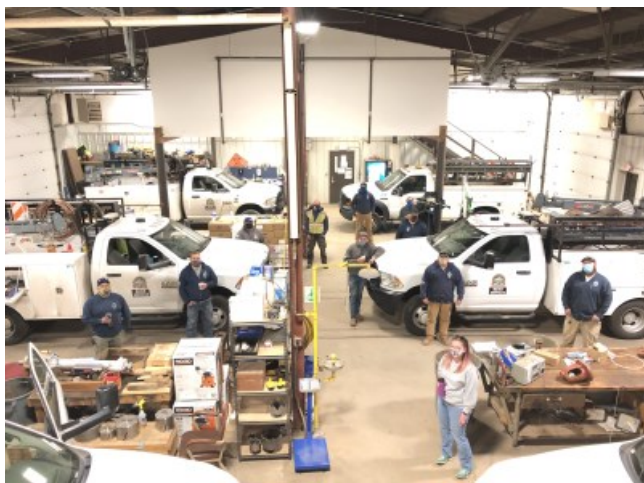
The ten objectives addressed in the plan are:

- ◆ Use standards and data to drive decision making
- ◆ Address Wildcat Hill Water Reclamation Plant capacity
- ◆ Protect the water system from wildfire threat
- ◆ Upgrade stormwater system and increase maintenance
- ◆ Accelerate infrastructure maintenance and replacement
- ◆ Ensure adequate water resources and plan for climate change
- ◆ Maintain excellent water quality
- ◆ Improve compliance with environmental standards and projections
- ◆ Enhance communications and customer service
- ◆ Address critical workforce issues



Crafted by our leadership team, this Plan does not communicate final policy decisions, but lays the groundwork for future discussions with policy makers and the public on specific strategies and investments. Leadership provided two bi-annual updates in 2020, and posted to our website with a section for the public to provide comments. Provide comments at: [Flagstaff.az.gov/4332/Strategic-Plan-2025](https://flagstaff.az.gov/4332/Strategic-Plan-2025).

The Communications, Customer Service and Water Conservation teams met monthly in 2020 to track goals in Strategic Objective 9: Enhance Communications and Customer Service.



Water Distribution staff members at the East Side Shop, minus a few.



Staff at the Water Services Administration Building before the 2021 retreat.

1-3 Notable Awards and Events

Notable Events in 2020

The notable event in 2020 was the emergence of the COVID 19 virus and the subsequent impact it had on the entire world. This virus, while throwing the country into seclusion, also threatened to send the city into an economic recession. Swift action taken by City administration curtailed purchases, projects and hiring, making routine tasks even more difficult.

Additionally, it was determined the virus was evident in wastewater, through fecal matter. This put wastewater and reclamation staff at even greater risk, than the general public. Through swift action, common-sense precautions and emergency protocols in place, we're finally able to safely see the pandemic wind down, with no interruptions in quality or service. Great job, TEAM!

Notable Awards in 2020



GOLD Status Achieved on G480 Leaderboard for Water Efficiency Efforts

Flagstaff's Water Conservation Program earned a Gold level on the Alliance for Water Efficiency G480 Leaderboard, in recognition of Water Services' incorporation of voluntary industry standards that promote water efficiency. The G480 Standard identifies critical elements of an effective water conservation program, such as dedicated staff for conservation efforts, a water waste ordinance, universal metering practices, a landscape efficiency program, and a water loss control program. Flagstaff is the first city in Arizona to join other top utilities in the nation on the Leaderboard, demonstrating an innovative and successful water conservation program!

EPA Excellence Award for WaterSense Promotions

The Environmental Protection Agency awarded Flagstaff Water Services a 2020 [WaterSense](#) Excellence Award, for its promotion of WaterSense-labeled products, designed to reduce water consumption and save money. In 2019, Water Conservation staff helped businesses and residents replace 1,150 toilets, 2,080 showerheads and 3,500 aerators through rebates, incentive programs and product giveaways. As an EPA WaterSense partner, Flagstaff consistently promotes water efficiency and WaterSense products.



2

2020 PRODUCTION & TREATMENT SUMMARY

2-1 Population

Year	1990	1995	2000	2005	2010	2015	2020
Population	45,403	52,701 ¹	52,894 ²	61,270 ⁴	65,870 ³	70,643 ⁴	75,219 ⁵

1. The Census Staff during a special census in 1995 completed the documented population count
2. Disputed census population
3. 2010 Census
4. Population estimate as of July 1 of that year from the Office of Economic Opportunity, as per City of Flagstaff Planning Section; includes NAU
5. State, County, Place Level Population Estimates. Because a decennial census was conducted in 2020, the July 1, 2020 population estimates are provisional. When the Census 2020 results are published mid-year, the Office of Economic Opportunity will revise these provisional estimates and produce final population estimates for July 1, 2020

2-2 Potable Water Production in the City of Flagstaff

	Acre-Feet Per Year ¹	Average Day (MGD) ²	Peak Day (MGD) ²
2020	8,434	7.5	11.0
2019	8,129	7.3	10.8
2018	8,035	7.2	10.5

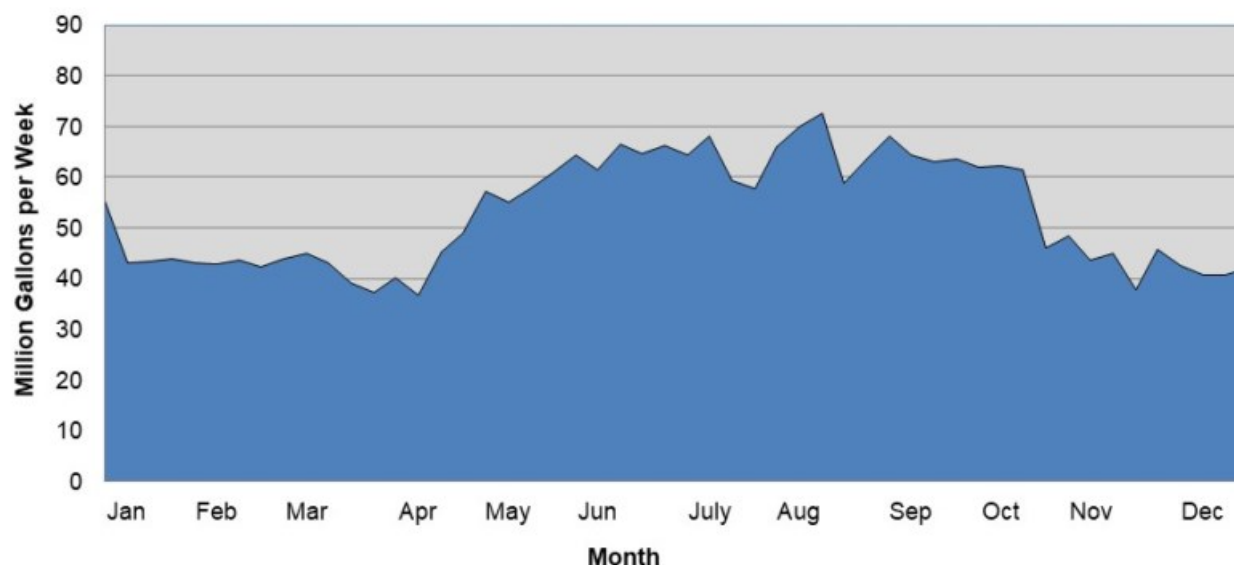
1. An acre-foot of water is equal to 325,851 gallons
2. MGD = million gallons of water per day

The **peak day production** occurred on July 31, 2020 with 10.96 million gallons (MG) produced. The sources of water used to meet peak production came from:

Peak Production Source	7/31/2020
Local Wells	2.24
Woody Mountain Wells	1.96
Lake Mary Surface Water	4.74
Lake Mary Wells	1.80
Inner Basin Water	0.22
Total Produced	10.96

Without surface water from Upper Lake Mary, or without water from the Inner Basin, Water Services has a peak capacity of ~12.9 MGD (details in **Section 7**). Assuming 15% system redundancy (85% of the firm well capacity) and no surface water sources (Inner Basin and Upper Lake Mary) our peak capacity is 11.0 MGD. Having surface water increases the peak capacity to ~21 million gallons per day including the Inner Basin (2 MGD) and Upper Lake Mary (6.0 MGD).

Water Production by Week—2020



Water use is traditionally higher from April to October, peaking pre-monsoon, due primarily to outdoor watering. Efforts by the community and Water Services over time have focused on reducing waste and increasing water efficiency in order to delay expensive water resources and infrastructure projects. The chart above shows 2020 as an unusual year with abnormally higher water use extending from June through October due to historically low monsoon precipitation.

2-3 Wastewater Treatment

Maximum Month & Day ¹ Wastewater Volume Treated				
Water Reclamation Plants (WRP)				
Rio de Flag WRP		Wildcat Hill WRP		Total Peak Day, MGD
Peak Month, MG Peak Day, MGD		Peak Month, MG Peak Day, MGD		
March 2020	59.7 MG 2.0 MGD 3/12/20	March 2020	127.1 MG 6.0 MGD 3/14/20	8.0 MGD
March 2019	60.4 MG 2.2 MGD 3/22/19	March 2019	163.5 MG 8.6 MGD 03/01/19	10.8 MGD
July 2018	56.8 MG 2.0 MGD 1/19/18	October 2018	116.9 MG 5.9 MGD 10/04/18	7.9 MGD

AVERAGE PER CAPITA INFLOW	1990	105	GPCD
	2020	67 ²	GPCD

- Maximum day units are in million gallons per day (MGD) and maximum month are in million gallons (MG). Flows are based on the influent metering system.
- Total influent (1.851 million gallons in 2020) divided by population (75,219) divided by 365 days.

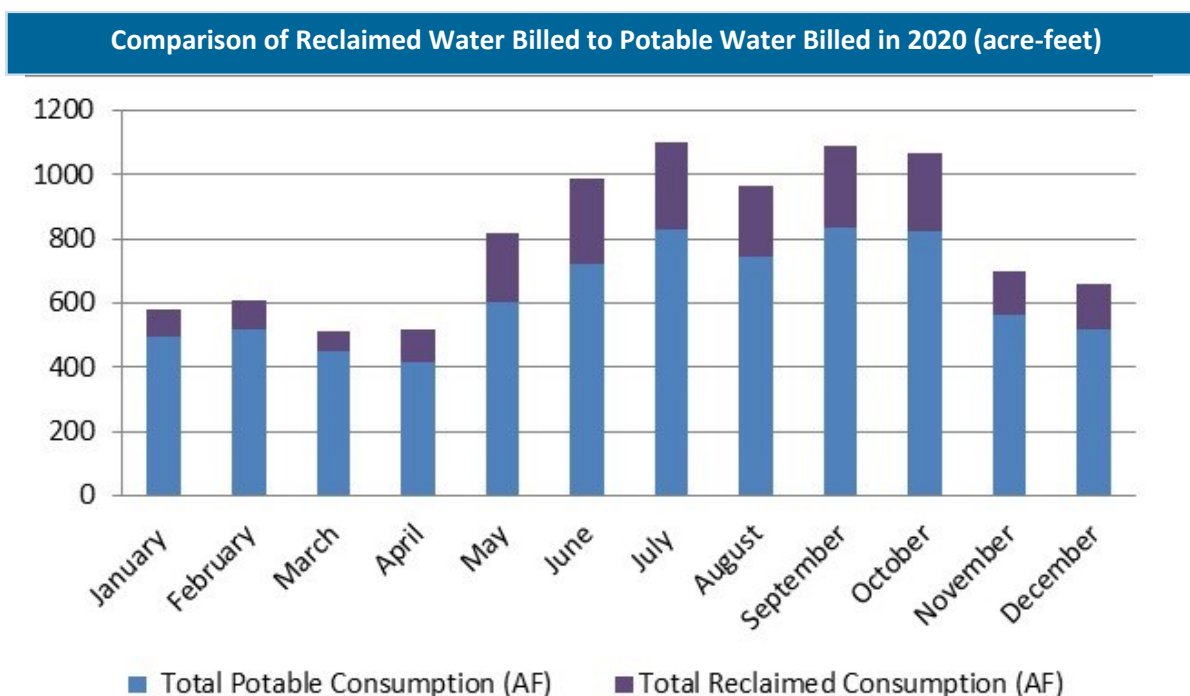
The treatment capacity of the Wildcat Hill Water Reclamation Plant is 6.0 MGD and the Rio de Flag Water Reclamation Plant is 4.0 MGD. The combined treatment capacity of the two plants is 10 MGD with occasional managed exceedance due to inflow and infiltration of stormwater into the sewer system (I&I). While this capacity is projected to serve the City of Flagstaff until 2035 or approximately a population of 100,000 (Sewer Master Plan, 2015 Brown & Caldwell), solids capacity has become the limiting factor, requiring significant financial investment by 2024.

2-4 Reclaimed Water Deliveries

Maximum Month & Day Reclaimed Volume Delivered				
Water Reclamation Plants (WRP)				
Rio de Flag WRP		Wildcat Hill WRP		Total Peak Day, MGD
Peak Month, MG Peak Day, MGD		Peak Month, MG Peak Day, MGD		
July 2020	37.5 1.7 MGD 3/20/20	June 2020	28.9 1.5 MGD 5/28/20	3.2 MGD
September 2019	35.6 1.6 MGD 8/30/19	July 2019	69.3 1.3 MGD 07/23/ 19	2.9 MGD
December 2018	36.9 1.8 MGD 10/13/18	April 2018	68.0 1.4 MGD 11/6/18	3.0 MGD

- Maximum day units are in million gallons per day (MGD) and maximum month are in million gallons (MG). Direct deliveries to customers only, does not include discharge to Rio de Flag.

Currently, the maximum reclaimed water supply available from the Rio de Flag WRP is 1.8 MGD and 3.4 MGD from the Wildcat Hill WRP. The supply availability from the Rio de Flag WRP is limited by the amount of inflow into the plant. The supply availability from the Wildcat Hill WRP is limited by the under-sizing of infrastructure between the plant and the Buffalo Park Tank. The Bushmaster Pump Station was completed in 2018 but an increase from an 8-inch to a 20-inch pipe is still necessary to increase flow to Buffalo Park Tank.



The monthly production graph above demonstrates the importance of reclaimed water in reducing the demand on potable water during spring and summer months. In May through October, reclaimed water accounted for 27% of total water demand. Reclaimed water continues to account for ~ 21% of water supplies delivered to customers on an annual basis.

3

2020 WATER PRODUCTION PLAN

This section describes the strategy Water Production will follow in order to meet anticipated water demands for 2021.

Over the last four years Water Production has sought to maximize surface water production while keeping disinfection by-products (DBPs) well under maximum contaminant levels (MCLs). This culminated in 2020 with the production of just over 1 billion gallons surface water with DBPs in check. Over 1 billion gallons surface water production was more than any year since 2011; and only accomplished 21 times since 1949 (see page 21.)

In addition, last year Water Production shifted focus to infrastructure rehabilitation and replacement. In the fall of 2020, Water Production completed the rehabilitation of the Woody Mountain Booster Station (WMBS) Clarifier, a structure that was put in place in the late 1950's and was overdue for attention. With all new stainless-steel equipment, new valves and a new layer of roofing, the WMBS Clarifier is now in great shape for another half century of service. In 2020 the design for the LMWTP Sedimentation Basin Improvement Project was also completed, addressing infrastructure and equipment there that is also overdue for attention and replacement.

With Upper Lake Mary around 40% full and little winter run-off yet this year, in 2021 Water Production will shift away from maximizing surface water production, leaning heavier on all groundwater supplies, while continuing infrastructure repair and replacement. By dividing supply between available sources, we will optimize capital investments while making new ones and utilize remaining available surface water. Optimizing all water supplies will make it possible to respond quickly to unplanned needs, utilize equipment investments, manage system wide disinfection and disinfection by-products, and continue infrastructure rehabilitation and replacement in Water Production. Water Production sets a target volume for Upper Lake Mary when below 50% full at 20% full coming into the next calendar year. This leaves enough water to help meet peak water demands pre-monsoon the following summer should the lake see unsatisfactory runoff that spring.

2020 Quarterly Operations Plan

1st Quarter (actual)				2nd Quarter (estimated)		
	Avg MGD	MG	AF	Avg MGD	MG	AF
Surface	1.1	100	326	1.3	120	391
LM Wells	0.8	75	244	1.2	110	358
WM Wells	1.8	160	521	2.5	225	733
Local Wells	2.5	225	733	2.9	260	847
IB	0.0	0	0	0.2	20	65
Total	6.2	560	1824	8.1	735	2394
3rd Quarter (estimated)				4th Quarter (estimated)		
	Avg MGD	MG	AF	Avg MGD	MG	AF
Surface	1.5	140	456	1.0	90	293
LM Wells	1.3	115	375	1.1	100	326
WM Wells	2.9	265	864	2.7	250	815
Local Wells	2.9	265	864	2.2	200	652
IB	0.3	30	98	0.0	0	0
Total	8.9	815	2657	7.0	640	2086

Peak Day and Total Annual Operations Plan

	Peak	Annual Estimate	
Source	Day MGD	MG	AF
Upper Lake Mary	6.0	450	1466
Local Wells	5.0	950	3096
Lake Mary Wells	3.2	400	1303
Woody Mountain Wells	5.0	900	2933
Inner Basin	1.5	50	163
Total	20.7	2750	8961
Minus 15% Well Redundancy	17.6		

4

2020 SUMMARY

4-1 2020 Notable Capital Investments

Wastewater Operations - Wildcat Hill Water Reclamation Plant

1. Enhanced security systems, by installing more cameras at strategic locations
2. Repaired 120 feet of grit line piping from the 1970s due to failure. Grit line piping transports very abrasive materials from the wastewater for ultimate disposal at the landfill.
3. Replaced all primary clarifier launder supports (weir mechanisms to settle out solids)
4. Rebuilt multiple pieces of equipment, as needed, over the year
5. Replaced the digester overflow hatch
6. Continued to work on improving safety of staff (Web Safety Plus Software)
7. Updated Emergency Plan
8. Purchased diagnostic tools to help with predictive maintenance program
9. Installed a hawk perch due to a citizen's wildlife habitat concern
10. Gas cleaning system installed for future Co-Gen system

Wastewater Operations - Rio de Flag Water Reclamation Plant

1. Enhanced security systems, by installing more cameras at strategic locations
2. Multiple pumps rebuilt or repaired
3. Continued to work on improving safety of staff (Web Safety Plus Software)
4. Worked on emergency plan
5. Purchased diagnostic tools to help with predictive maintenance program
6. Repaired concrete structures and replaced valves
7. Installed a radar sensor for better control of our Sodium Hypochlorite inventory
8. Rebuilt 3 -250 HP reclaim motors and installed insulated bearings
9. Installed a weather station to track wind speed and direction, temperature, humidity, barometric pressure and precipitation to help predict intrusion and inundation of precipitation with the wastewater influent
10. Rebuilt several cells in the sandfilter that had failed

Water Production Operations

1. Completed the design (with ADEQ approval) of the Lake Mary Water Treatment Plant (LMWTP) Sedimentation Basin Improvement Project with design engineers Brown & Caldwell.
2. Rehabilitated/upgraded the Woody Mountain Booster Station (WMBS) Sand Clarifier with new equipment (stainless steel clarifier (drive, arms, rakes, feed-well & walkway), recoated structural beams, and inlet piping, replaced roofing (including new stainless-steel cover) and replaced drain valves.
3. Cleared all city owned high voltage lines of vegetation (pine trees) in the Woody Mountain Wellfield and around the WMBS and associated Sand Clarifier.
4. Rehabilitated/re-surfaced all Woody Mountain Wellfield roads with new material.
5. Installed the first ever Manual Transfer Switch (MTS), for use with back-up generators, at the LMWTP; and installed shore power (power for block heaters and battery chargers) at the LMWTP and North Reservoir Filtration Plant for all 5 portable gensets; and tested all critical water production locations & transfer switches with new generators.
6. Re-equipped Woody Mountain #2 (submersible pump, motor & seal); reconfigured and re-equipped Sinagua Well.
7. Replaced/upgraded the Remote Terminal Units (RTUs) with Programmable Logic Controllers (PLCs) at Shop Well, Woody Mtn. #10 and Woody Mountain Booster Station.
8. Replaced the variable frequency drive (for submersible equipment) at Foxglenn Well (see page 25).

4-1 2020 Notable Capital Investments, continued

Water Production Operations, continued

9. Repaired/replaced 6 tank mixers (solarbees/gridbees) at LMWTP Clearwell, Railroad Springs, Cheshire, Paradise, Christmas Tree, and Main Storage Tanks.
10. Lined one the sludge drying beds at the LMWTP with a concrete base.
11. Repaired the 27" raw water pipeline supplying the LMWTP and repaired rip-rap at the ULM Dam.
12. Cleaned the Raw Water Pump Station groundwater clear well (140,000 gallons)
13. Painted the inlet/distribution piping at LM9, WM7, WM9, WM10, WMBS, LMWTP Town pump Building, & Interchange Well. Painted the exterior of Foxglenn/Sinagua Storage tank & interior of LMWTP Caustic Building.
14. Tested all Woody Mtn. Wellfield groundwater wells for non-regulatory arsenic (without federal or state mandate).
15. Produced over 1 billion gallons surface water, more than any year since 2011 and only accomplished 20 times in the history of the LMWTP.

Engineering

Aging Water Infrastructure Replacement (AWIR) Program Summary: Water Services replaced over 13,875 linear feet (LF) of aging water main during the 2020 calendar year, including:

1. Coconino Estates Waterline Replacement: Replaced 4,530 LF of 8-inch cast iron water main originally installed in 1958 along Navajo and Talkington Street
2. Fir Avenue Waterline Replacement: Replaced 2,075 LF of 12-inch cast iron water main originally installed in 1962 along Fir Avenue from Mesa Drive to San Francisco Street. Infrastructure replacement included all pavement, curb & sidewalk and edge improvements.
3. Industrial Drive Waterline Replacement: Replacement of 2,075 LF of 16-inch cast iron water main originally installed in 1960 along Industrial Drive from Steves Boulevard to Caden Court street in East Flagstaff
4. Summit Waterline Replacement: Replacement 3,300 LF of 6-inch cast iron water line with new 8-inch PVC water main from Spring Street to Sante Fe Avenue. Infrastructure replacement included all pavement, curb & sidewalk and edge improvements.

Aging Sewer Infrastructure Replacement (ASIR) Program Summary: Water Services replaced over 4,340 feet of aging sewer main during the 2020 calendar year, including:

1. Coconino Estates Waterline Replacement: Replaced 3,530 LF of 8-inch vitrified clay sewer main originally installed in 1958 along Navajo and Talkington Street.
2. Route 66 Bridge replacement, Sewer line Replacements: Replacement 785 LF of 18-inch ductile iron sewer line with new 18-inch sewer mains. Infrastructure replacement required to facilitate ADOT Bridge replacement along Route 66.
3. Phoenix Avenue Culvert Sewer Replacement: Replaced 25 LF of existing sewer line in conflict with the Stormwater Culvert improvement project. The project was for utility relocation work required to accommodate FY21 stormwater improvement.

4-2 2020 Water Management Summary

City of Flagstaff Water Management Summary 2020			
WATER PRODUCTION			
I.	C Aquifer Groundwater	5,095 AF	(48% of Total Water Produced)
	Lake Mary wells	1,125 AF	(60% of Total Potable Produced)
	Woody Mtn wells	1,228 AF	
	Local wells	2,742 AF	
II.	Upper Lake Mary Surface Water	3,183 AF	(30% of Total Water Produced)
			(38% of Total Potable Produced)
III.	Inner Basin Water	157 AF	(1% of Total Water Produced)
	Inner Basin wells	0 AF	(2% of Total Potable Produced)
	Inner Basin spring water	157 AF	
2020 TOTAL POTABLE PRODUCED		8,435 AF	
III.	Reclaimed water (direct delivered)	2,085 AF	(20% of Total Water Produced)
	Golf Courses	1,108 AF	
	Manufacturing	16 AF	
	Municipal parks, schools	177 AF	
	Commercial, NAU, Snowbowl	714 AF	
	Construction	68 AF	(reclaimed hydrant meters & standpipes)
	Residential	2 AF	
	Discharged to Rio de Flag	3,236 AF	(not included in total)
2020 TOTAL WATER PRODUCED		10,520 AF	
POTABLE WATER USED			
I.	Residential	4,508 AF	(60%)
	Single-Family	2,794 AF	(16,031 household meters)
	Multi-Family	1,714 AF	(3,085 multi-family meters)
II.	Non-Residential	3,007 AF	(40%)
	Commercial, CCC, NAU	2,319 AF	(1,677 commercial meters)
	Manufacturing	231 AF	(40 meters)
	Landscape/Lawn	365 AF	(333 meters)
	Standpipe	92 AF	
2020 TOTAL WATER BILLED		7,515 AF	
NON-REVENUE WATER [produced – billed/produced]:		920 AF or 11%	
	Water main flushing	6 AF	
	System leaks detected and repaired	N/A for 2020	
	Other	914 AF	(i.e., system flushing, water meter inaccuracy)
AVERAGE WATER USE		Total GPCD or GPHD	
I.	Gallons per capita per day (gpcd) is the potable water used in gallons / 75,219 population		
	Residential =54 gpcd & Non-Residential = 36 gpcd = 89 Total gpcd (does not include Non-Revenue)		
	Total - 100 gpcd (includes Non-Revenue)		
II.	Single family residential water use: 0.17AF/house/year or 156 gallons/house/day (GPHD)		
	[2,794AF/16,031meters] or [2,794 AF * 325,851 gallons/AF]/16,031 meters		

5

WATER SERVICES COMMUNICATIONS

5-1 Outreach methods

Website

Website development was a top priority in 2020. Our team served as an available and adaptable resource for not only Water Services staff, but also played a key role in providing outreach services for project managers in Divisions throughout the City. The communications team assisted managers in creating and managing the following webpages:

- The **Water Services** landing page was significantly reconstructed to streamline the information presented in over 75 webpages with clickable icons. This page had **19,600 views**.
- The **Water Conservation** landing page was revamped with icons created to direct users to pages to track water use and find information about programs. This page had **1,750 views**.
- A new **Stormwater Maintenance** page was created, which includes a story map with details about open and closed channel maintenance projects throughout Flagstaff. This page had **960 views**.
- The **Community Stakeholder Committee on Reclaimed Water (CSCRW)** webpage was created as a resource for stakeholders and the public to stay up to date on the progress of the Reclaimed Water Master Plan. This page had **200 views**.
- The **Rio de Flag Flood Control Project** webpage was created as a portal of information for the public and key stakeholders to follow the progress of the city-wide project with periodic updates, maps, videos, virtual meeting rooms and FAQs. This page had **750 views**.
- The **Fort Tuthill Utility Improvements Project** page posted weekly updates with information shared by the Coconino County on this joint project, including new water and sewer lines. This page had **130 views**.
- Four **Coconino Estates Improvements Project** webpages were created and managed. These pages include maps, contacts, photos, updates, descriptions and costs to keep residents well informed about the construction progress in their neighborhood. This page had **1,136 views**.
- **Capital Improvement Map (CIP)**- The CIP map tracks water projects around the city. Viewers can find details on the cost, location, manager, description, timeline, and contractor of each City project pinned on the map.
- **Story Maps**- Story maps were developed to provide a visual update on active construction of the Linda Vista PRV and Stormwater Culverts upsizing, and the Woody Mountain Clarifier Rehabilitation Project. These maps include photos and captions that users can scroll through to learn visually about the projects.

Water Talk News

The **News** webpage provided updates to keep the public informed about:

- **Get Ready for Winter Weather!** - Tips on how to prevent frozen pipes is shared as winter approaches.
- **Introducing the Community Stakeholder Committee on Reclaimed Water** – Sharing the biographies of the 13 committee members providing input regarding the future of reclaimed water in Flagstaff.
- **Are You Ready for this Monsoon Season?** -This message encouraged Flagstaff residents to utilize checklist as a tool to prepare for potential flooding during summer monsoons.
- **Wildfires Then, Wildfires Now: Yes, It Really Has Been Ten Years Since the Schultz Fire** – A look back at the 2010 Schultz Fire to reflect on lessons learned and acknowledge that fires will remain an ongoing consideration.
- **Water Services 2020 Report to the Water Commission is Published** – The annual reports are available to all via the Water Services website and limited paper copies.
- **Backflow Prevention: It's Important to You and Your Community** – Notifying the Flagstaff public about the importance of backflow devices, including proper annual testing, installation, maintenance, and certification.
- **Wondering What to do About the Sandbags on Your Property?** – Encouraging residents and business owners to keep post-Museum Fire sandbags in place on their properties through the 2020 monsoon season.
- **Water Services Receives the City Manager's 'Aspen Award'** –This accomplishment was shared with the public, highlighting the Water Services Leadership team for creating the Strategic Plan 2025.

5-1 Outreach methods (continued)

E-Blogs – Water Reliability Today and Tomorrow

Monthly Quick Reads brings the reader up-to-date on:

- **Planning for the Next Decade** The release of the Water Services Strategic Plan 2025.
- **Are There "Forever Chemicals" in Our Drinking Water?** PFOS and PFOA not detected in Flagstaff drinking water.
- **Linda Vista Drive Construction Tackles Two Water Projects Simultaneously** A pressure control valve is replaced and a stormwater culvert is upsized.
- **Keeping Your Water Clean and Safe** Continuing work to build resiliency and redundancy into Flagstaff's water system.
- **Brad Hill, Water Services Director, Retires After 12 Dedicated Years** We thanked Brad Hill for his many contributions to the Water Services Division.
- **Focus on Infrastructure Development for Summer 2020** The summer kicked off with several shovel-ready Capital Improvement Projects.
- **Ground-Breaking Infrastructure Upgrades Continue This Summer** Highlights of the Coconino Estates Utility Project and the Industrial Drive Waterline Replacement Project.
- **Updates on Stormwater Maintenance in Flagstaff** Staff upgraded inlet structures, organized stream cleanups and expanded the rain and stream gauge network.
- **Flagstaff Water Services Receives Two National Water Conservation Awards** The Water Conservation Program was recognized by the Alliance for Water Efficiency and the Environmental Protection Agency for excellence in conservation programming.
- **Planning for Flagstaff's Water Future** The Reclaimed Water Master Plan will identify options and policy for using uncommitted reclaimed water to support future water needs, with input from a Community Stakeholder Committee on Reclaimed Water (CSCRW).
- **Updates on Capital Improvement Projects Started in Summer 2020** Highlights five summer CIPs and links to Capital Improvement Map, following water projects around the city. Viewers can find details on the cost, location, project manager, description, timeline and contractor for each project location pinned on the map.
- **Woody Mountain Clarifier Project Wraps Up 2020 Capital Improvements** Water Services finished rehabilitating the water storage clarifier tank at the Woody Mountain Booster Station.

CityScope The only 2020 edition was published in February, featuring seven Water Services articles:

- Strategic Plan - Planning for the Next Decade
- Construction Notice: Linda Vista Drive
- Nine Steps to Ward Off Winter Woes
- Flagstaff Flood Safety and Awareness
- Stream Management: People Working Together to Help the Environment
- Reminder: FREE Residential and Commercial Water Consultations Available!
- Please Keep F.O.G Out of Your Drain

Facebook Communications and Water Conservation used this platform to promote events, blogs, news items, workshops, Water Commission meetings and anything of interest to the public. In 2020, Water Services created 160 posts, reaching over 25,000 people.

Presentations Staff gave 16 virtual presentations to the public and water groups in 2020. Topics included Division outreach, watershed health, water quality, water supply planning and conservation.

Public Outreach The communications team assisted the **Industrial Pretreatment Program** with several outreach efforts. We recruited for a Grease Interceptor Training and F.O.G Webinar. We facilitated outreach for the adoption of a new data management system, SwiftComply, for grease haulers. We circulated notices regarding proper backflow device removal and dental amalgam compliance to targeted groups. And we sent notices and held public comment meetings for stakeholders about Scavenger Waste Hauler Code changes and updates to the F.O.G Manual. Communications also lead the outreach effort for the **Linda Vista PRV and Culvert Upsizing Project**, with posters, radio spots and door hanger notifications of the impending construction in the neighborhood.

Partnerships Water Services continued its partnership with Roving Rangers, a volunteer group comprised of National Park Service (NPS) and U.S Forest Service (USFS) rangers, in 2020. Water Services developed and presented water-related curriculum to be shared with visitors at Flagstaff-area locations.

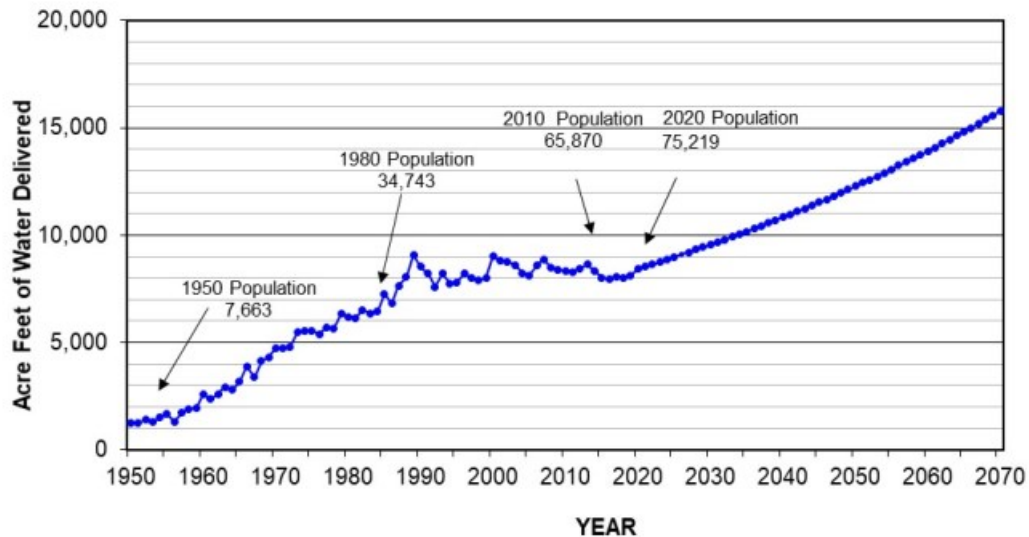


Communications Team: Lisa Deem, Joelle Sawaya, & Mary Samar

6

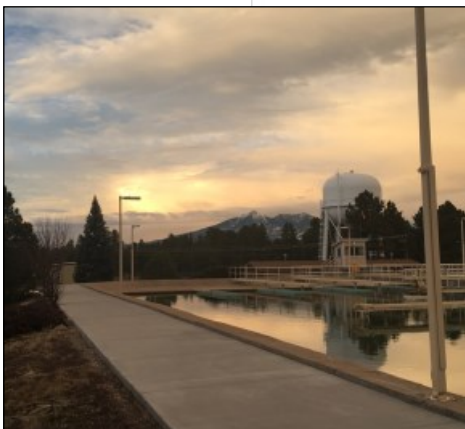
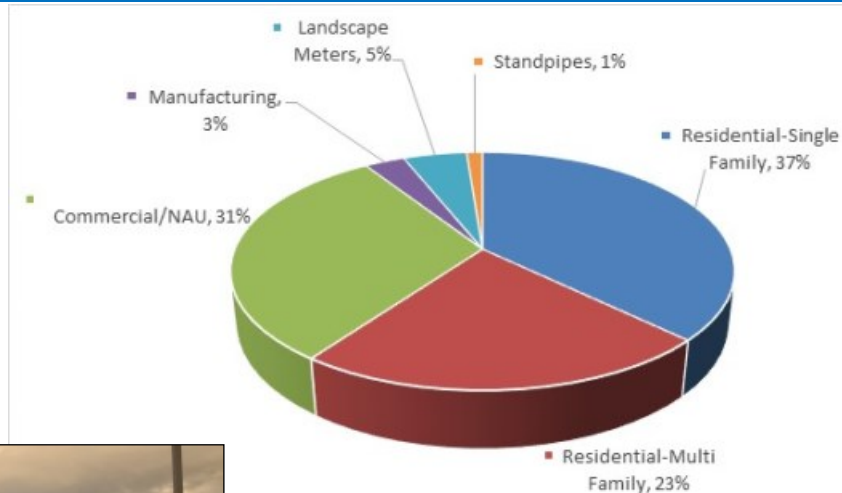
WATER CONSUMPTION & PROJECTED NEEDS

6-1 Projected Potable Water Demand from 2019 to 2070



The graph above illustrates water production (in acre-feet per year) and population for Flagstaff from 1950 through 2020. The annual percentage increase in population over the 69 year period has been 1.30% per year while water production has increased 1.22% per year over the same time period. Projected water demand assumes population growth and water use will continue at these same rates.

6-2 2020 Potable Water Use by Customer Class

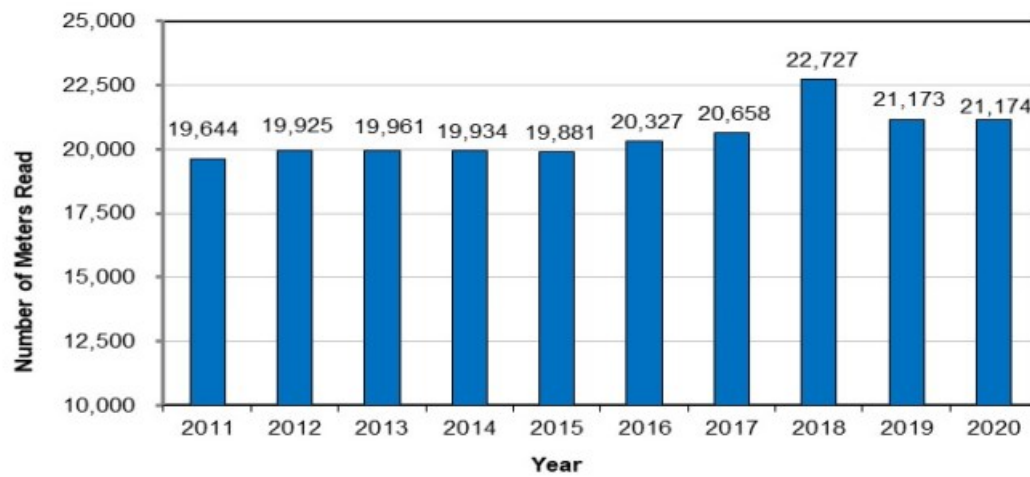


Lake Mary Water
Treatment Plant

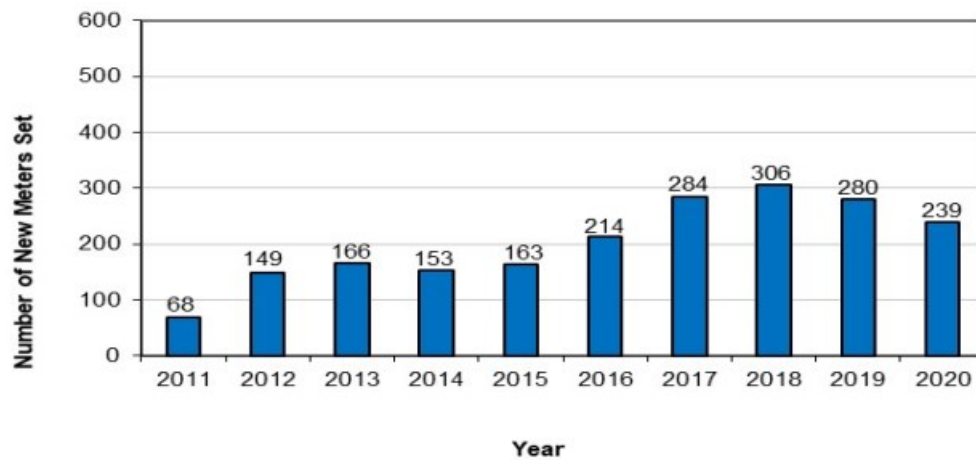


6-3 Water Meters

Meters Read—Highest Month Each Year for Last 10 Years



New Meter Sets in Last 10 Years



A staff member turns on the Snowbowl meter

6-4 Designation of Adequate Water Supply

The Arizona Department of Water Resources (ADWR) issued the City a Designation of Adequate Water Supply in 2013. The City pledged 9,913 AF/YR (acre-feet per year) of local groundwater (Lake Mary, Woody Mountain and Local well fields), 3,585 AF/YR from Upper Lake Mary, 16,500 AF/YR from Red Gap Ranch, and 2,212 AF/YR of reclaimed water as available supplies to meet 100 years of projected water demand. The supply from Red Gap Ranch is limited to 8,000 AF/YR after the City entered into an agreement with the Navajo Nation in 2011.

Water demand is based on current water demand, committed water demand and projected water demand. Current demand is what was produced each year. Committed demand represents all undeveloped properties with a building permit. Projected demand is the total volume for council approved plats.

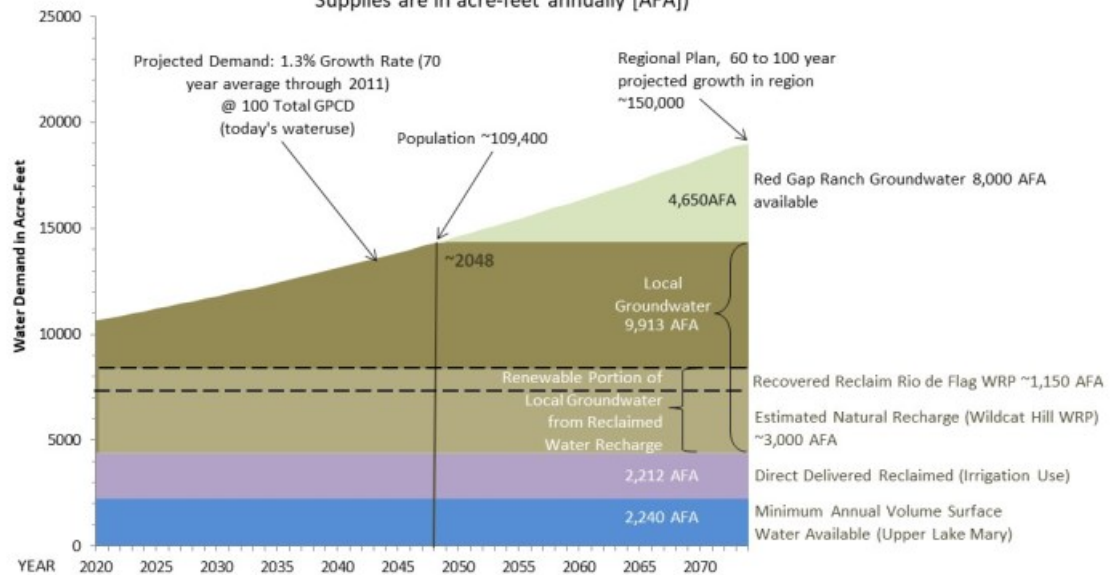
Flagstaff shall submit an application to increase the term of the designation when the sum of Flagstaff's current demand, committed demand and two-year projected demand exceeds 14,839.54 acre-feet per year, or by December 31, 2031, whichever is earlier.

Reporting Year	Current Demand Potable (AFA)	Current Demand Reclaimed (AFA)	Total Current Demand ¹ (AFA)	Committed Demand ² (AFA)	Remaining Designation Volume Before DADE Modification ³ (AFA)
2020	8,435	2,085	10,520	675	3,645
2019	8,129	1,740	9,869	1,412	3,559
2018	8,036	1,870	9,906	1,118	3,816
2017	8,065	2,189	10,254	1,263	3,323
2016	7,979	1,817	9,795	686	4,358
2015	8,013	1,921	9,934	833	4,073
2014	8,347	1,934	10,281	1,058	3,501
2013	8,565	2,252	10,817	819	3,204
2012	8,384	2,050	10,434	707	3,699
2011	8,249	2,212	10,461	859	3,520

1. Total current demand reported to ADWR is the sum of potable production and reclaimed water delivered in that calendar year.
2. Committed demand is Council -approved plats, building permits and rezones approved but not served.
3. 2033 Annual Estimated Water Demand from 2011 (14,840 AF) - Total Current Demand - Committed Demand.

City of Flagstaff 100-Year Designation of Adequate Water Supply

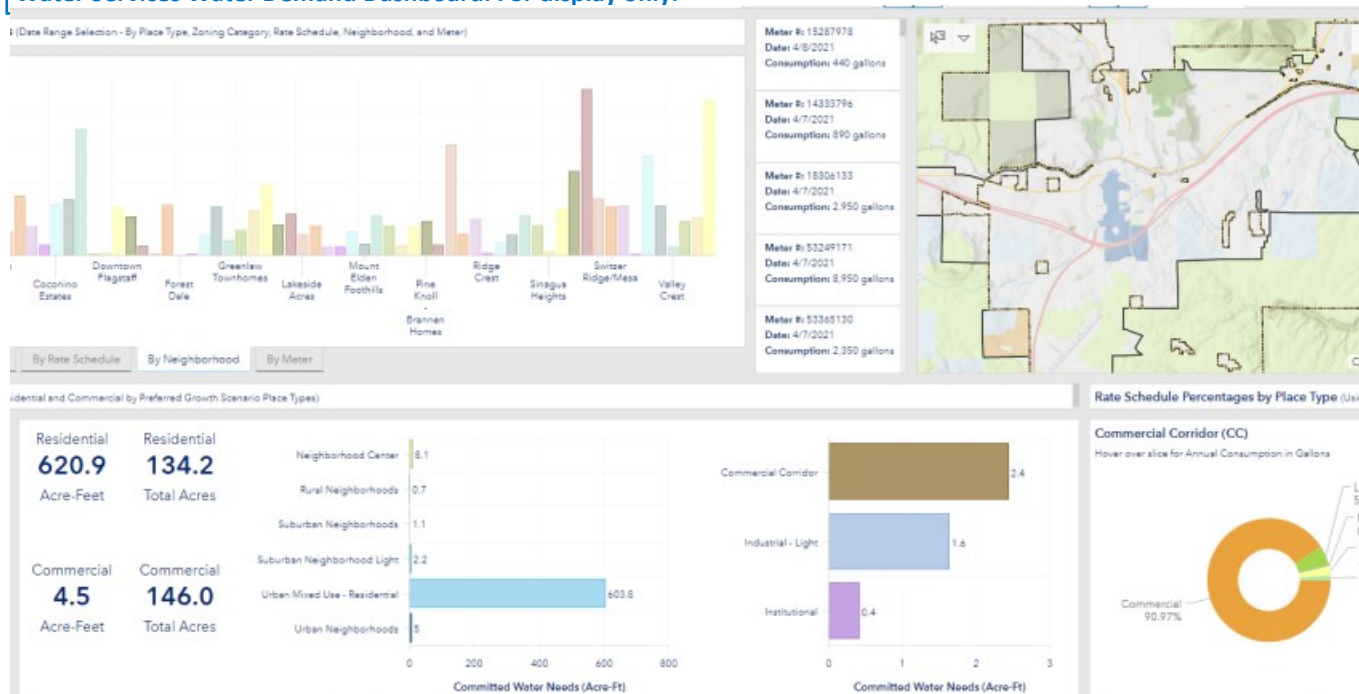
(as accepted by Arizona Department of Water Resources
Updated June, 2021 with current GPCD
Supplies are in acre-feet annually [AFA])



6-5 Water Consumption & Demand Data in GIS—New Water Demand Dashboard

A new tool was developed in the City's ArcGIS system in 2020 that displays water consumption and water demand spatially and volumetrically, referenced as the City of Flagstaff Water Demand Dashboard. The dashboard displays water consumption by Place Type (Place Types are defined in the Regional Plan), Zoning, Rate Schedule, Neighborhood, and Meter, for any given time increment back to 2017. Water demand is displayed for both maximum build-out, as defined in Flagstaff's Regional Plan 2030, as well as by the City's Designation of Adequate Water Supply categories of Projected (platted) and Committed (Regional Plan) demand categories.

Water Services Water Demand Dashboard. For display only.



6-6 Reclaimed Water Master Plan—Aquifer Recharge Feasibility Study Results

The Water Resources Section completed an aquifer recharge feasibility study in cooperation with the consulting company Natural Channel Design Inc. The recharge study was completed by releasing reclaimed water at the same or similar flow rates to three stream segments within the City including Bow and Arrow Wash at Lonetree, Sinclair Wash at Lonetree, and Switzer Canyon Wash near Jay Lively Ice Arena. A fourth stream reach, the Rio de Flag at the Rio WWTP was also analyzed for long-term seepage rates. Water was released for up to a week at each flow rate, monitoring the point in space and time at which discharge to the stream reached equilibrium before determining soil and groundwater infiltration. The results are provided in the below table, distances are the length of channel required for the flow to completely disappear: The infiltration rates can also be compared to other measurements completed by the Stormwater Section.

Table 1. Aquifer Recharge Feasibility Study, aquifer seepage rate results (Natural Channel Design 2020).

	~250 gpm	500 gpm	770 gpm	1000 gpm
Rio de Flag*	3,700 ft	8,300 ft	12,500 ft	14,600 ft
Sinclair Wash		4,950 ft	5,700 ft	
Bow and Arrow Wash	1,054 ft	2,720 ft		2,990 ft
Switzer Wash		8,180 ft		

*RDF did not experience steady flows and these lengths of channel are based on mean flows for a short duration

Table 2. Soil infiltration rates from field measurements (Cheshire neighborhood) and an aquifer recharge study (Natural Channel Design 2020). The percent loss per 100 linear feet of channel is probably more insightful than gross stream losses.

Location	Flow (gpm)	% loss (per 100 linear ft)	Infiltration (gpm/linear ft)	Infiltration (CFS/mile)
Rio de Flag, Cheshire neighborhood 2019	81	37.0	0.3	3.48
Rio de Flag, Cheshire neighborhood 2020	6.5	0.6	0.0004	0.00
Bow & Arrow Wash at Lonetree Rd.	250	9.5	0.237	2.75
Bow & Arrow Wash at Lonetree Rd.	500	4.6	0.23	2.67
Bow & Arrow Wash at Lonetree Rd.	1000	3.3	0.334	3.88
Switzer Wash at Oak St.	480	1.5	0.071	0.82
Switzer Wash at Oak St.	570	0.6	0.032	0.37
Rio de Flag at I-40	197	2.1	0.041	0.48
Rio de Flag at I-40	416	1.1	0.045	0.52
Sinclair Wash at Lonetree Rd.	550	1.7	0.096	1.12
Sinclair Wash at Lonetree Rd.	770	1.2	0.094	1.09

The study indicates that the Rio de Flag and its tributaries have significant ability to recharge reclaimed water to the ground. The fate of the reclaimed water to reservoir in the shallow ground water (soil water) system or continue to the regional aquifer is unknown without further research.

Specifically, it is recommended that tracer studies could illuminate how much water is being lost to shallow ground water and how much is contributing to the regional aquifer.

Geophysics (controlled-source audiomagnetotellurics) is another method that could demonstrate areas of loss to the deeper C aquifer.

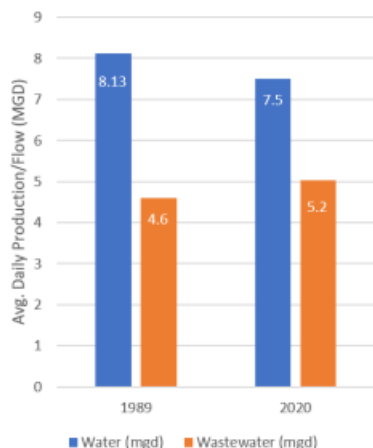
Citation:

Summary Report—Aquifer Recharge Feasibility Study Seepage Evaluation, February, 2021. Natural Channel Design, Inc., Flagstaff, Arizona. Contract #2019-92

Figure 1. Location of 2020 study sites with reclaimed water flow releases (right).

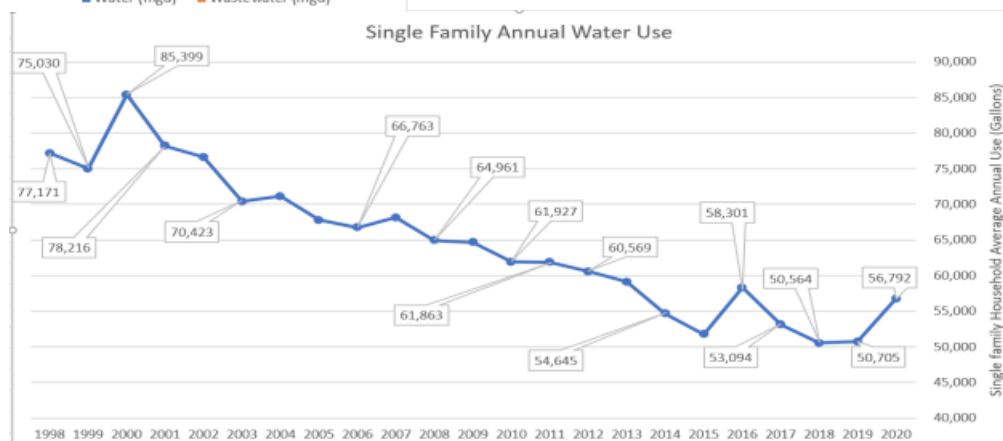
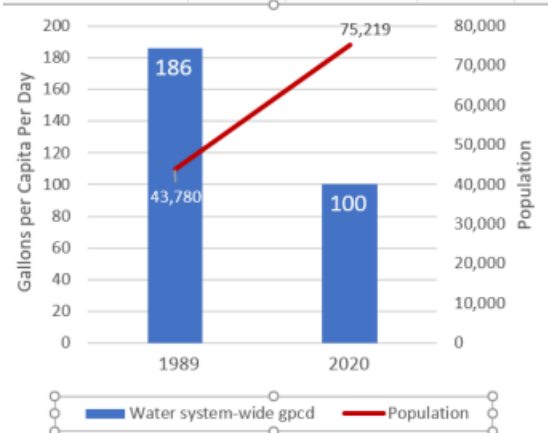


6-7 Water Resources Planning Data Trends



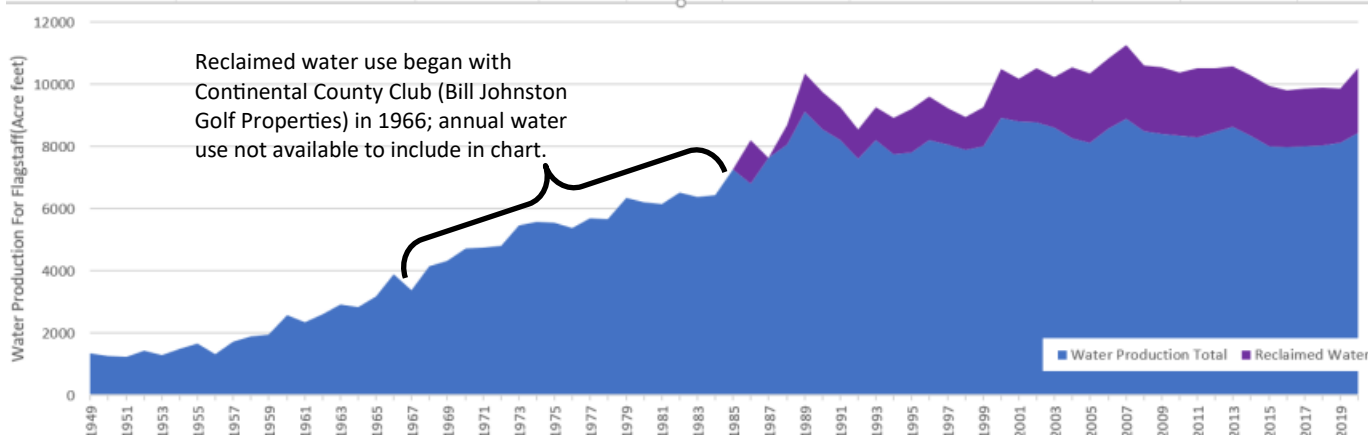
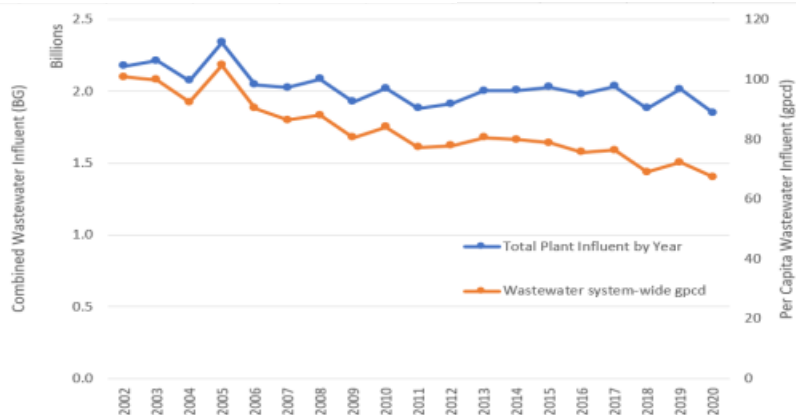
Right: Population has increased significantly since 1989. While community water consumption has decreased, the amount of wastewater generated has increased.

Left: The average daily production for water was less in 2020 than 1989, while average daily production on the wastewater side has gone up.



Left: Annual average water use in the single-family residential sector has dropped by 30,000 gallons a year per account since 1989.

Right: One issue facing Water Services and the wastewater treatment section is the decoupling of wastewater inflow and per capita contribution. Inflow is relatively consistent each year (with the exception of 2018) even with a growing population, while the gallons per day per-capita of inflow has been dropping. This relationship demonstrates that sewage concentration is increasing. Concentration is a growing concern for the industry as it becomes more difficult to process with conventional treatment.



7

WATER PRODUCTION

7-1 Water Wells Peak Capacity



Contractors assemble the components of the McAllister Well to complete the pumphouse project.

2021 Estimated Wells Peak Capacity			
Local Wells Maximum Production (GPM)		Lake Mary Wells Maximum Production (GPM)	Woody Mountain Wells Maximum Production (GPM)
Continental-2	310	LM 1 125	WM 1 125
Foxglenn	300	LM 2 360	WM 2 245
Sinagua	275	LM 4 415	WM 3 570
Shop	920	LM 5 290	WM 4 320
Ft. Tuthill	1,135	LM 8 655	WM 5 280
Interchange	190	LM 9 240	WM 6 405
Rio	200		WM 7 550
McAllister	Online July 2021		WM 9 400
*Foxglenn/Sinagua pumphouse limited to max volume of 600 GPM			WM 10 280
			WM 11 355
Total GPM	3,330 GPM	2,085 GPM	3,530 GPM
Total MGD	4.8 MGD	3.0 MGD	5.1 MGD
TOTAL PEAK WELL CAPACITY			12.9 MGD
WITH ONE HIGH-CAPACITY WELL REDUNDANCY (15%)			11.0 MGD

7-2 Historical Production By Source Data

YEAR	Lake Mary Surface			Inner Basin Spring			Inner Basin Wells			Woody Mtn. Wells			Lake Mary Wells			Local Wells			TOTAL			Calendar Precip in Inches	Snow (Oct-April) inches
	AF	MG		AF	MG		AF	MG		AF	MG		AF	MG		AF	MG		AF	MG			
1949	278.75	90.83		1077.98	351.26														1356.72	442.09		26.40	
1950	775.02	252.54		488.81	159.28														1263.83	411.82		10.76	63.30
1951	1131.68	368.76		102.90	33.53														1234.58	402.29		25.79	73.40
1952	210.89	68.72		1219.88	397.50														1430.78	466.22		20.60	105.90
1953	1044.71	340.42		262.08	85.40														1306.79	425.82		12.81	60.00
1954	1182.29	385.25		321.31	104.70														1503.60	489.95		19.55	89.00
1955	1488.75	485.11		190.27	62.00														1679.02	547.11		17.97	67.80
1956	825.35	268.94		114.47	37.30					383.70	125.03								1323.52	431.27		10.37	42.70
1957	1159.67	377.88		476.91	155.40					87.52	28.52								1724.10	561.80		24.59	53.00
1958	616.29	200.82		1191.65	388.30					97.90	31.90								1905.84	621.02		21.24	71.50
1959	1591.95	518.74		301.67	98.30					49.19	16.03								1942.82	633.07		21.46	63.80
1960	1745.37	568.73		547.49	178.40					275.99	89.93								2568.84	837.06		16.60	77.60
1961	1618.62	527.43		352.92	115.00					388.15	126.48								2359.70	768.91		18.95	53.90
1962	1519.44	495.11		890.59	290.20					209.79	68.36								2619.82	853.67		18.11	128.90
1963	1663.37	542.01		118.15	38.50					1145.58	373.29								2927.10	953.80		14.52	47.30
1964	1303.69	424.81		342.18	111.50					1184.19	385.87								2830.07	922.18		19.04	89.40
1965	1713.51	558.35		1164.34	379.40					291.54	95.00								3169.39	1032.75		36.59	166.70
1966	2361.39	769.46		919.13	299.50		2.15	0.70		598.56	195.04								3881.22	1264.70		20.58	83.40
1967	2906.82	947.19		444.99	145.00		3.38	1.10		34.74	11.32								3389.92	1104.61		22.27	63.10
1968	2988.54	973.82		772.75	251.80		165.32	53.87		213.63	69.61								4140.24	1349.10		16.53	150.40
1969	2722.07	886.99		930.18	303.10		324.20	105.64		296.76	96.70		42.41	13.82					4315.62	1406.25		23.41	134.70
1970	3206.56	1044.86		686.51	223.70		477.49	155.59		349.24	113.80		0.00	0.00					4719.80	1537.95		24.02	95.70
1971	2600.39	847.34		188.12	61.30		497.56	162.13		999.87	325.81		477.06	155.45					4763.01	1552.03		21.01	56.60
1972	1953.04	636.40		235.69	76.80		538.56	175.49		1625.50	529.67		459.69	149.79					4812.48	1568.15		24.67	50.30
1973	3594.59	1171.30		1043.42	340.00		366.00	119.26		464.63	151.40		0.00	0.00					5468.63	1781.96		19.71	210.00
1974	3999.44	1303.22		189.26	61.67		411.45	134.07		821.51	267.69		144.79	47.18					5566.44	1813.83		17.41	70.00
1975	2209.84	720.08		711.52	231.85		429.64	140.00		1038.27	338.32		1160.65	378.20					5549.93	1808.45		20.10	141.10
1976	3415.92	1113.08		489.00	159.34		543.19	177.00		942.15	307.00		0.00	0.00					5390.26	1756.42		20.12	131.60
1977	2606.99	849.49		66.66	21.72		518.92	169.09		1755.96	572.18		744.63	242.64					5893.15	1855.12		18.77	70.20
1978	2754.63	897.60		629.12	205.00		480.31	156.51		1197.45	390.19		602.42	196.30					5663.94	1845.60		30.72	116.20
1979	3782.83	1232.64		1049.90	342.11		449.35	146.42		773.42	252.02		288.32	93.95					6343.82	2067.14		19.68	145.50
1980	3863.91	1259.06		1128.12	367.60		652.05	212.47		512.38	166.96		56.19	18.31					6212.66	2024.40		29.30	177.10
1981	3308.75	1078.16		181.77	59.23		740.92	241.43		1041.95	339.52		865.12	281.90					6138.51	2000.24		23.37	92.40
1982	3775.56	1230.27		796.47	259.53		603.65	196.70		741.14	231.50		611.32	199.20					6528.14	2127.20		31.09	96.90
1983	2892.27	942.45		1148.93	374.38		427.22	139.21		1038.05	338.25		858.46	279.73					6364.93	2074.02		29.47	142.60
1984	2770.16	902.66		253.52	82.61		726.25	236.65		1967.28	641.04		717.87	233.92					6435.09	2096.88		20.09	32.00
1985	4540.94	1479.67		721.16	234.99		398.83	129.96		663.86	216.32		934.45	304.49					7259.24	2365.43		26.67	136.00

7-2 Historical Production By Source Data, continued

YEAR	Lake Mary Surface			Inner Basin Spring			Inner Basin Wells			Woody Mtn. Wells			Lake Mary Wells			Local Wells			TOTAL			Calendar Precip in inches		Snow (Oct-April) inches
	AF	MG		AF	MG		AF	MG		AF	MG		AF	MG		AF	MG		AF	MG				
1986	4235.89	1380.27		541.35	176.40		715.70	233.21		268.40	87.46		1055.05	343.79		6816.40	2221.13		6816.40	2221.13		32.39		105.40
1987	5701.38	1857.80		467.27	152.26		637.16	207.62		7.55	2.46		822.58	268.04		7635.94	2488.18		7635.94	2488.18		23.98		121.60
1988	5339.25	1739.80		86.91	28.32		778.52	253.68		125.30	40.83		1731.71	564.28		8061.69	2626.91		8061.69	2626.91		21.68		104.50
1989	355.99	116.00		0.00	0.00		839.71	273.62		3371.79	1098.70		4539.10	1479.07		9106.59	2967.39		9106.59	2967.39		14.44		77.70
1990	101.89	33.20		35.11	11.44		279.27	91.00		3411.38	1111.60		4713.35	1535.85		8540.99	2783.09		8540.99	2783.09		25.67		113.40
1991	3512.34	1144.50		134.69	43.89		38.36	12.50		2313.33	753.80		2217.88	722.70		8216.61	2677.39		8216.61	2677.39		21.83		127.90
1992	3012.42	981.60		214.82	70.00		293.69	95.70		1267.14	412.90		2817.55	918.10		7605.62	2478.30		7605.62	2478.30		34.71		159.40
1993	4130.42	1345.90		550.56	179.40		194.26	63.30		1624.06	529.20		1718.27	559.90		8217.56	2677.70		8217.56	2677.70		35.25		147.10
1994	3428.87	1117.30		236.00	76.90		271.90	88.60		1901.18	619.50		1903.94	620.40		7741.88	2522.70		7741.88	2522.70		21.91		149.20
1995	3400.02	1107.90		432.71	141.00		303.51	98.90		1426.73	464.90		2256.55	735.30		7819.52	2548.00		7819.52	2548.00		17.79		109.50
1996	1900.41	619.25		0.00	0.00		345.13	112.46		3115.60	1015.22		2849.19	928.41		8210.32	2675.34		8210.32	2675.34		11.81		33.70
1997	1784.04	581.33		0.00	0.00		730.52	238.04		2709.37	882.85		2835.01	923.79		8058.93	2626.01		8058.93	2626.01		16.40		132.20
1998	3363.19	1095.90		482.15	157.11		129.60	42.23		1510.20	492.10		2393.12	779.80		7878.26	2567.14		7878.26	2567.14		27.36		137.00
1999	1186.49	386.62		151.20	49.27		240.11	78.24		3189.77	1039.39		3224.05	1050.56		7991.63	2604.08		7991.63	2604.08		15.79		63.00
2000	784.78	255.72		23.07	7.52		681.13	221.95		4013.39	1307.77		3410.12	1111.19		8912.49	2904.14		8912.49	2904.14		15.40		74.40
2001	946.75	308.50		162.25	52.87		267.42	87.14		3530.60	1150.45		3690.57	1202.58		8804.14	2868.84		8804.14	2868.84		17.59		125.10
2002	195.67	63.76		0.00	0.00		24.77	8.07		4779.91	1557.54		3334.68	1086.61		8767.93	2857.04		8767.93	2857.04		12.88		38.90
2003	615.77	200.65		18.81	6.13		188.71	61.49		4136.09	1347.75		3111.45	1013.87		8614.31	2806.98		8614.31	2806.98		17.91		54.90
2004	900.96	293.58		0.00	0.00		200.67	65.39		3625.86	1181.49		2213.25	721.19		8249.26	2688.03		8249.26	2688.03		23.61		50.30
2005	3670.33	1195.98		302.65	98.62		325.06	105.92		1775.60	578.58		1108.45	361.19		8127.55	2648.37		8127.55	2648.37		24.01		138.00
2006	1553.51	506.21		73.89	24.08		508.75	165.78		2551.64	831.46		2576.73	839.63		8589.25	2798.82		8589.25	2798.82		15.59		44.50
2007	294.70	96.03		38.82	12.65		336.00	109.49		4050.78	1319.95		2591.47	844.43		8884.92	2895.16		8884.92	2895.16		17.46		49.90
2008	2929.50	954.58		265.22	86.42		161.01	52.47		2352.76	766.65		1502.99	489.75		8484.67	2764.74		8484.67	2764.74		18.85		90.80
2009	3744.16	1220.04		262.09	85.40		0.00	0.00		1662.50	541.73		1412.75	460.35		8399.44	2736.97		8399.44	2736.97		11.65		138.20
2010	3987.93	1299.47		198.67	64.74		0.00	0.00		1460.55	475.92		1132.62	369.07		8351.63	2721.39		8351.63	2721.39		27.89		140.50
2011	3416.24	1113.19		0.00	0.00		0.00	0.00		1536.10	500.54		1109.53	361.54		8296.72	2703.49		8296.72	2703.49		20.67		103.60
2012	934.52	304.51		0.00	0.00		0.00	0.00		3063.61	998.28		1439.86	469.18		8458.42	2756.19		8458.42	2756.19		14.89		69.70
2013	1572.73	512.48		99.00	32.26		0.00	0.00		2774.00	903.91		1680.86	547.71		8644.92	2816.96		8644.92	2816.96		24.79		44.00
2014	1037.90	338.17		18.00	5.87		237.60	77.42		2574.60	838.87		1726.80	562.64		8347.00	2719.67		8347.00	2719.67		20.67		57.00
2015	1854.16	604.18		175.97	57.34		66.99	21.83		2096.88	683.27		1524.47	496.75		8013.08	2611.07		8013.08	2611.07		27.25		62.90
2016	1625.08	529.53		90.27	29.41		110.48	36.00		2064.12	672.60		1453.76	473.71		7978.69	2599.86		7978.69	2599.86		25.80		95.50
2017	1782.60	580.86		367.74	119.83		0.00	0.00		2126.15	692.81		1101.49	358.92		7991.74	2604.12		7991.74	2604.12		18.00		37.40
2018	2131.74	694.63		17.14	5.59		173.70	56.60		1759.25	573.25		1190.58	387.95		8035.75	2618.46		8035.75	2618.46		21.57		117.20
2019	2592.77	844.86		257.08	83.77		0.00	0.00		1311.28	427.28		1052.88	343.08		8128.62	2648.72		8128.62	2648.72		26.10		70.30
2020	3182.55	1037.04		156.53	51.00		0.00	0.00		1228.03	400.15		1124.97	366.57		8434.37	2748.35		8434.37	2748.35		9.59		94.13
Historic Average	2268.49	739.19		383.47	124.95		324.29	105.67		1567.78	510.86		1587.14	517.17		5975.01	1946.96		5975.01	1946.96		21.22		94.77
Percent of total	28.4%			4.8%			4.1%			19.6%			19.9%			23.2%			23.2%					
Historic Median	2042.39	665.52		259.58	84.58		303.51	98.90		1311.28	427.28		1301.66	424.15		6672.27	2174.17		6672.27	2174.17		20.64		90.80
Ave of last 5 yrs	2262.95	737.38		177.75	57.92		56.84	18.52		1697.77	553.22		1184.74	386.05		8113.83	2643.90		8113.83	2643.90		20.21		82.91
Percent of total	27.9%				2.2%			0.7%		20.9%				14.6%		33.7%			33.7%					

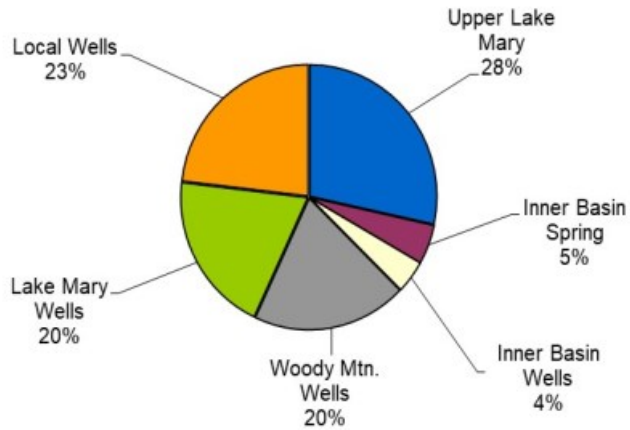
7-3 2020 Weekly Production By Source (Million Gallons)

MONTH	WEEK	TOTAL	LM SURFACE	LM WELLS	WM WELLS	R F P	LOC WELLS
January	1	55.29	20.558	4.365	9.946	0.000	20.418
	2	43.06	16.534	4.131	7.722	0.000	14.673
	3	43.42	17.314	4.454	7.598	0.000	14.058
	4	43.95	16.271	4.219	7.658	0.000	15.806
February	1	42.98	16.647	4.093	7.594	0.000	14.642
	2	42.80	14.921	4.088	7.586	0.000	16.206
	3	43.70	17.088	4.099	7.560	0.000	14.951
	4	42.27	13.646	4.190	7.730	0.000	16.699
March	1	43.87	15.937	4.153	7.314	0.000	16.470
	2	44.92	17.631	4.044	7.466	0.000	15.781
	3	43.13	16.160	4.159	7.465	0.000	15.350
	4	39.00	14.957	3.969	7.339	0.000	12.734
	5	37.25	16.673	3.956	4.040	0.000	12.586
April	1	40.05	19.526	3.880	3.960	0.000	12.684
	2	36.77	13.973	3.666	4.003	0.000	15.126
	3	45.27	18.109	4.245	3.998	0.000	18.915
	4	48.97	13.578	3.559	9.608	0.000	22.225
May	1	57.30	22.385	7.660	10.810	0.000	16.443
	2	54.97	19.877	6.857	5.750	4.635	17.853
	3	57.62	21.933	6.356	8.535	5.318	15.478
	4	60.82	27.976	4.136	6.825	4.113	17.772
June	1	64.45	29.835	4.361	6.509	6.857	16.888
	2	61.46	27.531	4.352	6.859	7.869	14.854
	3	66.42	28.949	7.590	6.860	5.339	17.683
	4	64.59	25.925	8.298	8.149	4.101	18.114
	5	66.15	14.639	11.173	20.990	1.118	18.229
July	1	64.28	21.882	6.265	17.070	3.163	15.899
	2	68.19	27.021	6.150	17.289	2.153	15.577
	3	59.42	6.914	11.934	21.128	1.785	17.657
	4	57.82	16.275	10.800	13.369	1.424	15.956
August	1	66.06	19.179	10.821	15.285	1.306	19.468
	2	69.85	24.975	10.506	12.721	1.121	20.530
	3	72.62	21.193	11.378	15.498	0.701	23.848
	4	58.80	10.785	10.971	17.757	0.000	19.289
September	1	63.61	25.879	10.501	11.219	0.000	16.006
	2	68.20	27.922	11.018	9.849	0.000	19.409
	3	64.32	27.057	13.588	2.920	0.000	20.756
	4	63.00	27.116	13.713	2.817	0.000	19.352
	5	63.57	26.716	14.344	2.912	0.000	19.597
October	1	61.87	27.050	13.462	2.906	0.000	18.452
	2	62.29	26.859	11.025	2.859	0.000	21.548
	3	61.53	26.288	10.624	2.829	0.000	21.789
	4	46.06	14.428	10.355	2.898	0.000	18.376
November	1	48.46	5.928	16.404	2.340	0.000	23.786
	2	43.52	20.479	5.921	2.786	0.000	14.329
	3	44.90	22.662	4.131	2.772	0.000	15.338
	4	37.89	19.865	2.852	2.358	0.000	12.815
	5	45.70	20.177	3.775	3.185	0.000	18.563
December	1	42.49	21.105	3.285	3.291	0.000	14.810
	2	40.63	19.442	3.658	4.078	0.000	13.453
	3	40.71	17.383	3.765	4.046	0.000	15.517
	4	42.09	13.882	5.273	4.105	0.000	18.827
Total year, 2020 (MG)		2748.35	1037.04	366.57	400.15	51.00	893.58
	Acre-Feet	8434.37	3182.55	1124.97	1228.03	156.53	2742.30
Total year, 2019 (MG)		2648.72	844.86	343.08	427.28	83.77	949.73
	TOTAL		LM SURFACE	LM WELLS	WM WELLS	RFP	LOC WELLS
2020 % of 2019		104%	123%	107%	94%	61%	94%
2020 % By Source			38%	13%	15%	2%	33%
AVG DAILY (mgd)		7.53	2.84	1.00	1.10	0.14	2.45

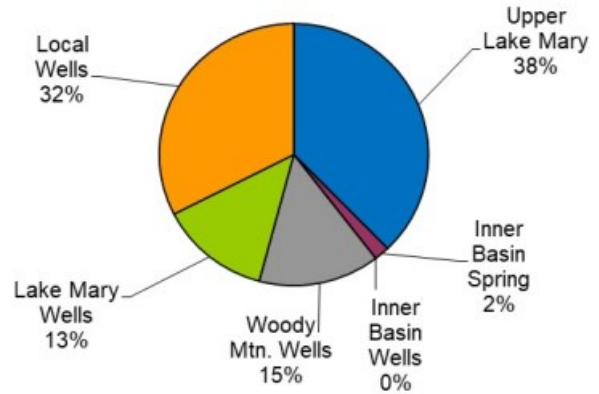
RFP = Reservoir Filtration Plant

Difference between total and sum of individual wells on page 19 & 20 is due to meter inaccuracies.

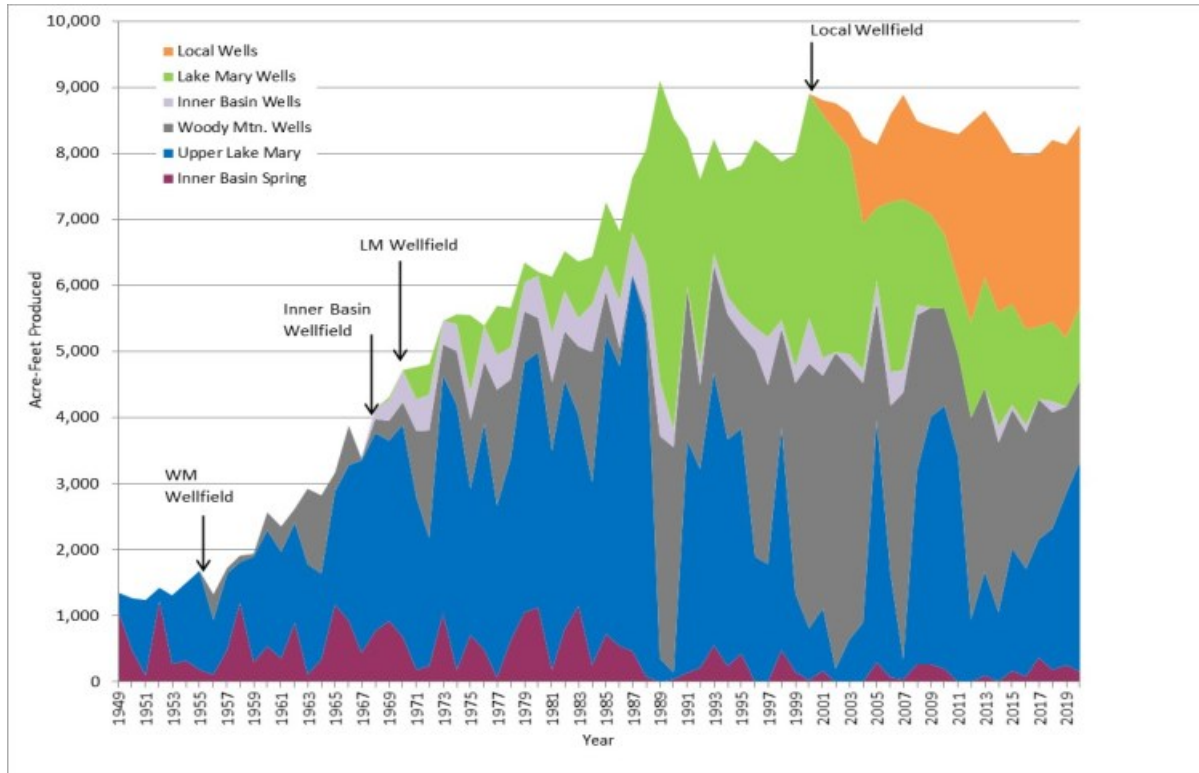
Historic Average (1949-2020)



Potable Water Supply 2020



Production by Source (1949-2020)



Videoring abandoned well on Beale Street.



Crews fix a water leak on Huntington Drive.

7-4 Most Recent Distribution System Water Quality at Each EPDS (Entry Point to the Distribution System)

	unit	MCL	Woody Mtn.	Year	N. Res. Plant	Year	003 Lake Mary	Year	004 Foxglen	Year	Continenta l	Year	Interchang e	Year	EPDS 007 Shop	Year	EPDS 008 Rio	Year	009 Ft. Tuthill
Arsenic	mg/L	0.01	0.0075	2017	<0.001	2017	0.0026	2015	0.003	2015	0.0017	2015	0.0021	2015	0.0017	2015	0.001	2020	0.0057
Barium	mg/L	2	0.64	2017	0.007	2017	0.18	2015	0.18	2015	0.52	2015	0.28	2015	1.1	2015	0.14	2020	0.47
Cadmium	mg/L	0.005	<0.0005	2017	<0.0005	2017	<0.0005	2015	<0.0005	2015	<0.0005	2015	<0.0005	2015	<0.0005	2015	<0.0005	2020	<0.0005
Chromium	mg/L	0.01	0.0013	2017	<0.001	2017	<0.001	2015	0.0023	2015	0.0029	2015	0.0023	2015	0.0014	2015	0.001	2020	0.0015
Fluoride	mg/L	4	0.09	2017	0.097	2017	0.087	2015	0.056	2015	0.12	2015	0.093	2015	0.1	2015	0.1	2020	0.082
Mercury	mg/L	0.002	<0.0002	2017	<0.0002	2017	<0.0002	2015	<0.0002	2015	<0.0002	2015	<0.0002	2015	<0.0002	2015	<0.0002	2020	<0.0002
Nitrate	mg/L	5	0.15	2020	<0.1	2020	<0.1	2020	0.039	2020	1.7	2020	0.66	2020	1	2020	1	2020	0.15
Nitrite	mg/L	0.5	<0.05	2018	<0.05	2018	<0.05	2019	<0.05	2018	<0.05	2018	<0.05	2018	<0.05	2018	<0.05	2018	<0.05
Selenium	mg/L	0.05	<0.005	2017	<0.005	2017	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2019	<0.005
Antimony	mg/L	0.006	<0.001	2017	<0.001	2017	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2019	<0.001
Beryllium	mg/L	0.004	<0.001	2017	<0.001	2017	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2019	<0.001
Cyanide	mg/L	0.2	<0.005	2017	<0.005	2017	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2019	<0.005
Nickel	mg/L	0.1	<0.005	2017	<0.005	2017	<0.005	2013	<0.005	2012	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2019	<0.005
Thallium	mg/L	0.002	<0.001	2017	<0.001	2017	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2019	<0.001
Sodium	mg/L	na	4.9	2020	2.1	2020	4.6	2020	7	2020	6.8	2020	4.3	2020	4.9	2020	4	2020	3.8
Asbestos	MFL	7	<0.2	2018	<0.2	2018	<0.2	2018	<0.2	2012	<0.2	2012	<0.2	2012	<0.2	2015	<0.2	2012	<0.2
Adjusted Gross Alpha	pCi/L	15	3.0 ± 0.7	2016	0.6 ± 0.5	2016	<1.0	2012	1.8 ± 0.8	2012	<1.0	2015	1.0 ± 0.7	2017	1.7 ± 0.6	2015	0.1	2017	1.7 ± 0.6
Combined Uranium	µg/L	30	0.9 ± 0.4	2016	<0.5	2016	1.8 ± 0.7	2012	1.2 ± 0.5	2012	1.5 ± 0.5	2015	0.8 ± 0.5	2017	1.0 ± 0.5	2015	2.0 ± 0.7	2017	1.0 ± 0.5
Combined Radium	pCi/L	5	0.6 ± 0.2	2016	<0.3	2016	0.4 ± 0.1	2012	0.5 ± 0.2	2012	<0.4	2015	0.4	2017	<0.6	2015	1.1	2017	<0.6

mg/L = milligrams per liter

MFL = million fibres per liter

pCi/L = picocuries per liter. Picocuries per liter is a measure of the radioactivity in water.

µg/L = micrograms per liter

Drinking water regulations only call for sampling every couple of years depending on the EPDS.

7-5 City Supply Wells & ADWR Registration Information

CADASTRAL	NAME	ADWR REGISTRATION NUMBER	DATE OF COMPLETION
A (21-06) 35 cbd	Woody Mtn Well #1	55-606201	Dec-54
A (21-06) 35 ccb	Woody Mtn Well #2	55-606202	Jul-56
A (21-06) 35 bcc	Woody Mtn Well #3	55-606203	Oct-57
A (21-06) 35 ccc	Woody Mtn Well #4	55-606204	Nov-57
A (20-06) 02 bbc	Woody Mtn Well #5	55-606205	Jun-63
A (20-06) 02 bdb	Woody Mtn Well #6	55-606206	Mar-68
A (20-06) 11 bab	Woody Mtn Well #7	55-606207	Apr-78
A (20-06) 11 cab	Woody Mtn Well #9	55-509026	Nov-85
A (20-06) 02 bcb	Woody Mtn Well #10	55-548560	Mar-96
A (20-06) 11 baa	Woody Mtn Well #11	55-559574	Jun-98
A (20-08) 18 bbb	Lake Mary Well #1	55-606195	Oct-62
A (20-08) 18 ccb	Lake Mary Well #2	55-606196	Dec-64
A (20-07) 12 dda	Lake Mary Well #3	55-606197	Sep-65
A (20-08) 19 aba	Lake Mary Well #4	55-606198	Jan-72
A (20-08) 20 dbc	Lake Mary Well #5	55-606199	Dec-75
A (20-08) 27 bdc	Lake Mary Well #7	55-606200	Dec-78
A (20-08) 20 cca	Lake Mary Well #8	55-501228	Mar-82
A (20-08) 30 cdb	Lake Mary Well #9	55-532282	Sep-91
A (23-07) 33 aab	Inner Basin Well #9	55-606209	Aug-68
A (23-07) 27 cca	Inner Basin Well #11	55-606210	Aug-71
A (23-07) 28 ddb	Inner Basin Well #14	55-606211	Aug-70
A (21-07) 24 aac	Foxglenn Well (EPDS 4)	55-559572	Jan-97
A (21-08) 17 bca	Continental Well-2 (EPDS 5)	55-560805	Feb-97
A (21-08) 07 dbb	Interchange Well (EPDS 6)	55-588998	Nov-02
A (21-08) 05 dca	Shop Well (EPDS 7)	55-588257	Dec-02
A (21-07) 23 cbb	Rio Well (EPDS 8)	55-599535	Nov-03
A (20-07) 06 adc	Ft. Tuthill Well (EPDS 9)	55-907084	Jan-08
A (21-07) 24 acd	Sinagua Well (EPDS 4)	55-907085	May-08
A (21-07) 19 bbd	McAllister Well	55-908260	Apr-09

* EPDS – Wells that are tested as an entry point to the distribution system (EPDS). See page 24 for drinking water quality data regulated by the Arizona Department of Environmental Quality. Other EPDS points include the Woody Mountain booster site (EPDS 001), Inner Basin water at the North Reservoir Plant (EPDS 002), and water from Upper Lake Mary (EPDS 003).

7-6 Power Cost—CY 2020

POTABLE		Electricity \$/Kgal			Total Power Cost	Water Produced (MG)	Total Megawatt	Cost Per Acre-foot
Water Source	Source	Raw Pump	Booster	Final Cost				
Lake Mary Plant	\$0.13	\$0.08		\$0.20	\$211,694.38	1037.04	2888.63	\$66.52
Lake Mary Wells	\$0.51	\$0.08		\$0.58	\$213,176.26	366.57	1941.49	\$189.50
Local Wells	\$0.89		\$0.05	\$0.94	\$836,967.40	893.58	9418.82	\$305.21
Woody Mountain Wells	\$0.92		\$0.05	\$0.97	\$387,516.07	400.16	3518.35	\$315.56
Inner Basin Wells & Springs	\$0.00		\$0.05	\$0.05	\$2,348.85	51.01	17.89	\$15.01
Weighted Avg				\$0.60				\$196
Total					\$1,651,703	2,748.35	17,785.18	

- Total electricity cost = Electricity Cost Data from Sustainability Division + Booster Station Cost Data from Water Production Section.
- Costs do not include operation and maintenance, staffing, or chemical treatment.
- Electrical charges to boost the water to homes in Flagstaff were distributed across WM, IB, and Local Wells only.
- No well water was produced from the Inner Basin in 2020.

Reclaimed Power Cost—CY 2020

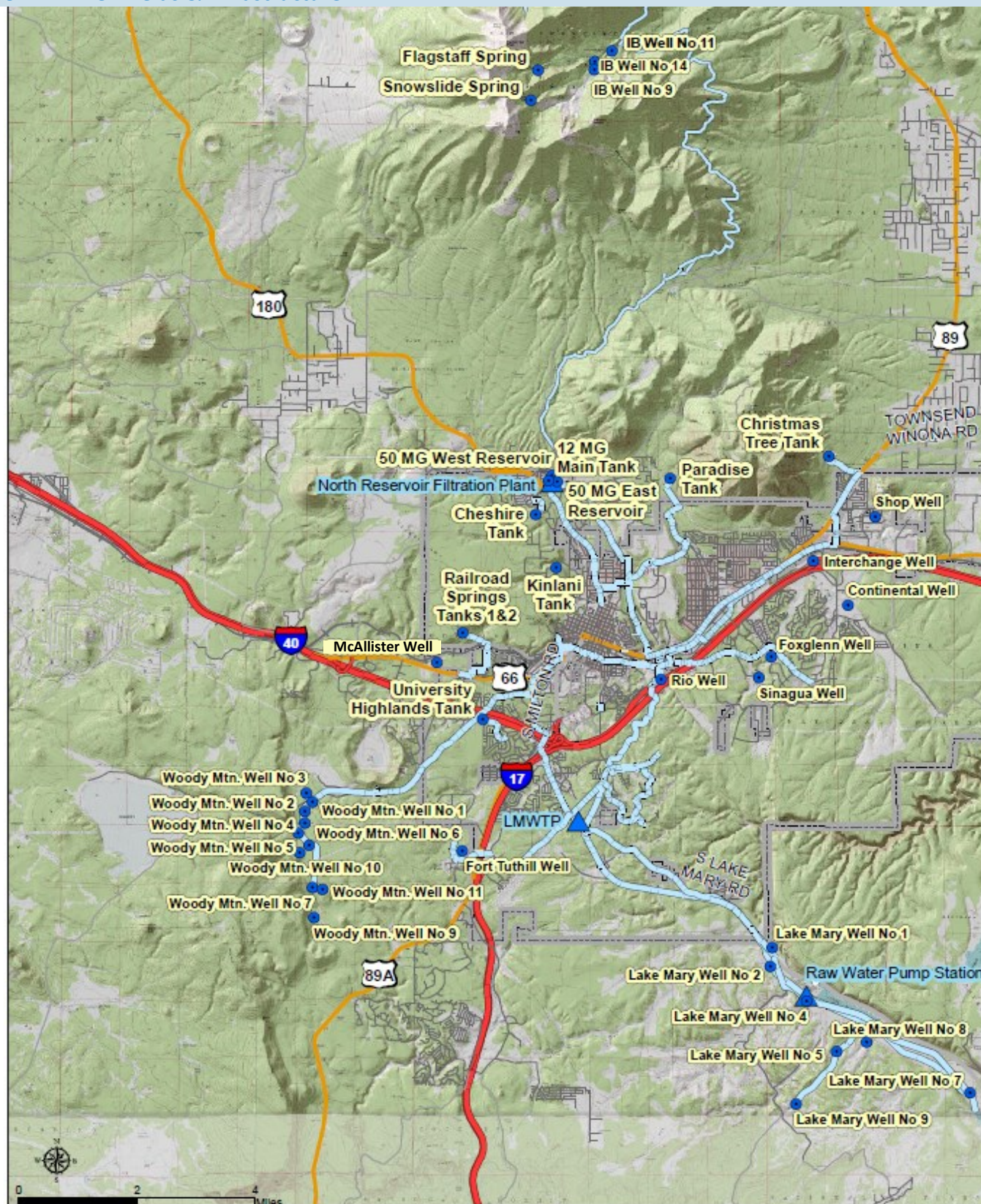
Water Reclamation Plant	2020 Electricity Used to Treat Influent to Plants (kWh)				Volume Treated (gallons)	Electricity Used to Deliver Reclaimed Water (kWh)	Total Reclaimed Delivered (gallons)
	APS	Solar	AZ Power Auth	Co-Gen			
Wildcat Hill	5,316,009	1,551,837	N/A	0	1,204,406,000	499,859	378,993,000
Rio de Flag	2,812,287	533,632	N/A	N/A	645,882,000	290,991	346,386,000
Totals	8,128,296	2,085,469	N/A	0	1,850,288,000	790,850	725,379,000
Cost to Utility	\$767,510	\$182,761	\$29,214	\$0		\$86,993	
Cost / acre-foot					\$172.50		\$39.08

- Data from Water Services Division, Wastewater Treatment Section
- Note the energy cost above for reclaimed water is only the cost to pump reclaimed water into the reclaimed water system. Wastewater is considered a commodity as reclaimed water once the wastewater treatment process meets its permitted water quality to discharge into the Rio de Flag.

8

2020 WELL FIELDS

8-1 Well Fields & Infrastructure



8-2 City of Flagstaff Well Production History 1997-Present (million gallons)

YEAR	FOXGLN	CONTL	SHOP	INTRCH	RIO	SINAGUA	TUTHILL	LOCAL	IB9	IB11	IB14	IB TOTAL
1997									55.870	59.120	14.460	129.450
1998									8.550	19.330	15.340	43.220
1999	5.010	3.230						8.240	51.380	26.080	0.780	78.240
2000	0.000	29.565						29.565	77.189	90.945	46.294	214.428
2001	66.149	1.560						67.709	0.000	31.323	55.815	87.138
2002	56.860	77.748						134.608	0.000	3.004	2.145	5.149
2003	72.821	67.674	17.909	18.683				177.087	0.000	51.057	10.435	61.492
2004	36.972	49.939	243.317	97.148				426.376	0.000	35.240	27.951	63.191
2005	34.637	23.189	196.500	53.758				308.084	64.602	39.444	1.870	105.916
2006	47.892	87.574	195.908	100.290				431.664	32.675	78.434	54.667	165.776
2007	126.331	63.106	217.610	69.060	45.310			521.417	0.000	45.476	64.011	109.487
2008	1.507	26.311	283.149	40.980	62.926			414.873	0.000	16.209	36.257	52.466
2009	0.000	0.000	400.700	6.860	28.494			436.054	0.000	0.000	0.000	0.000
2010	0.916	3.530	332.100	13.360	33.151	9.816	119.317	512.190	0.000	0.000	0.000	0.000
2011	29.726	8.138	339.660	7.360	16.680	18.389	308.334	728.287	0.000	0.000	0.000	0.000
2012	46.527	22.945	341.300	6.820	8.999	81.859	475.765	984.215	0.000	0.000	0.000	0.000
2013	20.172	16.327	270.500	3.800	16.848	65.110	427.843	820.600	8.163	24.695	0.000	32.858
2014	40.430	53.900	271.510	12.170	8.960	44.330	465.440	896.740	0.000	33.914	43.493	77.407
2015	20.840	21.580	273.880	16.720	34.730	20.200	359.740	747.690	21.835	0.000	0.000	21.835
2016	30.280	29.235	240.546	23.215	13.567	76.801	444.966	858.609	0.000	19.744	16.257	36.001
2017	16.100	20.043	299.298	4.391	6.334	100.669	404.856	851.691	0.000	0.000	0.000	0.000
2018	15.202	0.616	384.364	1.470	0.867	44.839	448.373	895.731	56.601	0.000	0.000	56.601
2019	36.853	0.000	374.468	2.390	18.990	101.526	422.365	956.592	0.000	0.000	0.000	0.000
2020	58.743	1.031	373.764	4.826	9.500	39.636	406.080	893.580	0.000	0.000	0.000	0.000
YEAR	LM1	LM2	LM4	LM5	LM7	LM8	LM9					LM TOTAL
1997	0.000	84.540	147.960	135.620		511.090	107.590					986.800
1998	17.590	2.460	85.860	92.270		487.110	135.370					820.660
1999	8.800	46.210	213.470	120.000		530.750	85.290					1004.520
2000	18.049	171.246	256.658	95.156		548.086	109.017					1198.212
2001	31.236	193.036	331.506	48.201		533.297	110.915					1248.191
2002	18.043	141.507	303.165	100.531	3.155	532.376	65.262					1164.039
2003	18.062	124.797	259.479	92.900	0.000	453.701	100.860					1049.799
2004	5.457	124.023	79.160	130.041	0.000	338.451	176.190					853.322
2005	11.002	44.665	63.565	24.370	0.000	200.544	40.717					384.863
2006	10.895	80.049	189.037	89.718	0.000	334.613	117.689					822.001
2007	33.275	91.488	233.631	100.913	16.447	305.751	72.482					853.988
2008	3.977	26.072	103.224	109.768	6.941	249.638	8.788					508.408
2009	4.103	35.694	112.210	3.526	0.000	252.675	49.133					457.341
2010	0.000	0.000	103.180	31.535	0.000	186.186	38.731					359.632
2011	0.000	0.000	134.570	22.095	0.000	133.152	65.001					354.818
2012	0.000	0.000	217.764	121.153	0.000	58.394	73.206					470.517
2013	0.000	0.000	149.343	59.407	0.000	251.275	83.193					543.218
2014	0.000	0.630	224.490	18.930	0.000	245.160	73.450					562.660
2015	0.000	61.929	128.494	55.409	0.000	186.722	63.372					495.926
2016	0.000	72.512	139.961	33.554	0.000	154.823	70.649					471.499
2017	0.000	30.883	46.956	22.451	0.000	206.451	49.245					355.986
2018	0.000	55.633	77.443	8.411	0.000	199.578	34.959					376.024
2019	0.000	43.684	41.464	16.537	0.000	198.787	33.223					333.695
2020	0.000	55.966	67.542	10.526	0.000	166.536	51.079					351.649
YEAR	WM1	WM2	WM3	WM4	WM5	WM6	WM7	WM9	WM10	WM11		WM TOTAL
1997	37.560	127.310	161.340	94.810	63.410	184.890	102.720	123.810	74.100			969.950
1998	0.000	28.860	31.080	34.190	67.490	104.280	221.090	52.740	20.630			560.360
1999	72.130	47.830	167.510	105.150	107.960	142.730	228.990	113.670	91.210			1077.180
2000	108.875	98.554	222.164	106.091	145.106	212.489	181.241	111.777	138.465			1324.762
2001	79.803	139.872	283.900	109.490	70.137	187.515	91.275	57.525	125.001	101.162		1245.680
2002	107.903	101.841	288.102	153.620	88.919	154.482	223.042	153.087	122.189	166.234		1559.419
2003	54.234	48.651	48.651	62.113	14.955	98.042	286.197	322.218	140.888	147.873		1223.822
2004	70.978	55.726	293.108	108.986	38.876	124.902	164.845	116.272	114.012	78.764		1166.469
2005	28.143	10.887	117.863	77.798	20.303	49.420	119.721	141.219	24.155	16.429		605.938
2006	65.498	80.910	142.982	25.047	55.920	128.174	74.025	125.994	79.033	37.299		814.882
2007	31.433	118.277	285.269	103.927	62.540	113.881	170.067	150.048	113.680	137.164		1286.285
2008	1.197	46.644	149.636	34.252	8.789	61.866	151.793	114.561	13.991	160.537		743.266
2009	3.199	3.249	100.105	7.054	1.615	123.519	147.408	120.969	1.788	19.648		528.554
2010	0.379	12.449	78.100	2.430	0.509	50.999	116.248	132.377	11.759	11.759		417.009
2011	4.499	2.902	120.155	6.948	2.975	65.582	178.185	70.566	0.000	39.779		491.591
2012	0.000	29.521	301.868	8.292	45.413	144.554	146.182	111.161	34.845	150.802		972.638
2013	0.000	18.430	169.470	31.094	11.720	158.563	272.729	94.067	34.211	91.083		881.367
2014	0.000	52.290	170.170	38.250	31.940	101.290	119.240	137.980	22.400	165.310		838.870
2015	0.000	59.110	93.718	11.118	20.983	155.571	89.978	120.278	17.909	109.322		677.987
2016	0.000	4.723	231.889	0.000	0.000	158.761	144.885	86.199	13.086	43.066		682.608
2017	0.000	4.428	242.207	0.000	14.277	83.479	84.253	129.472	51.962	69.683		679.762
2018	0.000	3.059	145.656	16.158	14.190	40.612	109.338	121.629	35.846	81.836		568.324
2019	0.000	24.108	37.223	9.683	18.642	127.584	20.513	90.079	30.043	62.169		420.044
2020	0.000	18.933	68.060	7.461	2.635	82.448	45.422	65.576	41.670	69.778		401.984
TOTAL ALL SOURCES												
YEAR	MG	YEAR	MG	YEAR	MG	YEAR	MG	YEAR	MG	YEAR	MG	
1997	2086.200	2001	2648.718	2005	1404.801	2009	1421.949	2013	2278.043	2017	1887.439	
1998	1424.240	2002	2863.215	2006	2234.322	2010	1288.831	2014	2375.677	2018	1896.679	
1999	2168.180	2003	2512.200	2007	2771.177	2011	1574.696	2015	1943.438	2019	1710.331	
2000	2766.967	2004	2509.358	2008	1719.013	2012	2427.370	2016	2048.717	2020	1647.212	

Quantities are in MILLION GALLONS from individual well meters. Totals will not necessarily match cumulative well field master meters due to unknown meter inaccuracies.

8-2 City of Flagstaff Well Production History 1997-Present (acre-feet) continued

YEAR	FOXGLN	CONTL	SHOP	INTRCH	RIO	SINAGUA	TUTHILL	LOCAL	IB9	IB11	IB14	IB TOTAL
1997								0	171.46	181.43	44.38	397.27
1998								0	26.24	59.32	47.08	132.64
1999	15.38	9.91						25.29	157.68	80.04	2.39	240.11
2000	0	90.73						90.73	236.88	279.10	142.07	658.06
2001	203.00	4.79						207.79	0	96.13	171.29	267.42
2002	174.50	238.60						413.10	0	9.22	6.58	15.80
2003	223.48	207.68	54.96	57.34				543.46	0	156.69	32.02	188.71
2004	110.39	153.26	746.71	298.14				1308.50	0	108.15	85.78	193.93
2005	106.30	71.16	603.04	164.98				945.48	198.26	121.05	5.74	325.04
2006	146.98	268.75	601.22	307.78				1324.73	100.28	240.71	167.77	508.75
2007	387.70	193.66	667.82	211.94	139.05			1600.17	0	139.56	196.44	336.00
2008	4.62	80.75	868.95	125.76	193.11			1273.20	0	49.74	111.27	161.01
2009	0	0	1229.70	21.05	87.44			1338.20	0	0	0	0
2010	2.81	10.83	1019.18	41.00	101.74	30.12	366.17	1571.85	0	0	0	0
2011	91.23	24.97	1042.38	22.59	51.19	56.43	946.24	2235.03	0	0	0	0
2012	142.79	70.42	1047.41	20.93	27.62	251.22	1460.07	3020.44	0	0	0	0
2013	61.91	50.11	830.13	11.66	51.70	199.81	1313.00	2518.33	25.05	75.79	0	100.84
2014	124.08	165.41	833.23	37.35	27.50	136.04	1428.38	2751.99	0	104.08	133.48	237.55
2015	63.96	66.23	840.51	51.31	106.58	61.99	1104.00	2294.58	67.01	0	0	67.01
2016	92.93	89.72	738.21	71.24	41.64	235.69	1365.55	2634.98	0	60.59	49.89	110.48
2017	49.41	61.51	918.51	13.48	19.44	308.94	1242.46	2613.74	0	0	0	0.00
2018	46.65	1.89	1179.57	4.51	2.66	137.61	1376.01	2748.90	173.70	0	0	173.70
2019	113.10	0.00	1149.20	7.33	58.28	311.57	1296.19	2935.67	0.00	0	0	0.00
2020	180.28	3.16	1147.04	14.81	29.15	39.64	1246.21	2742.30	0.00	0	0	0.00
YEAR	LM1	LM2	LM4	LM5	LM7	LM8	LM9					LM TOTAL
1997		259.44	454.07	416.20		1568.48	330.18					3028.38
1998	53.98	7.55	263.49	283.17		1494.89	415.44					2518.51
1999	27.01	141.81	655.12	368.27		1628.81	261.75					3082.76
2000	55.39	525.53	787.65	292.02		1682.01	334.56					3677.18
2001	95.86	592.41	1017.35	147.92		1636.63	340.39					3830.56
2002	55.37	434.27	930.38	308.52	9.68	1633.80	200.28					3572.30
2003	55.43	382.99	796.31	285.10	0	1392.36	309.53					3221.71
2004	16.75	380.61	242.93	399.08	0	1038.67	540.71					2618.75
2005	33.76	137.07	195.07	74.79	0	615.45	124.96					1181.10
2006	33.44	245.66	580.13	275.33	0	1026.89	361.17					2522.63
2007	102.12	280.77	716.99	309.69	50.47	938.32	222.44					2620.79
2008	12.20	80.01	316.78	336.87	21.30	766.11	26.97					1560.25
2009	12.59	109.54	344.36	10.82	0	775.43	150.78					1403.53
2010	0	0	316.65	96.78	0	571.38	118.86					1103.67
2011	0	0	412.98	67.81	0	408.63	199.48					1088.90
2012	0	0	668.29	371.80	0	179.20	224.66					1443.96
2013	0	0	458.32	182.31	1.00	771.13	255.31					1668.07
2014	0	1.93	688.93	58.09	0	752.37	225.41					1726.74
2015	0	190.05	394.33	170.04	0	573.03	194.48					1521.94
2016	0	222.53	429.52	102.97	0	475.13	216.81					1446.98
2017	0	94.78	144.10	68.90	0	633.57	151.13					1092.48
2018	0	170.73	237.66	25.81	0	612.48	107.29					1153.97
2019	0	134.06	127.25	50.75	0	610.05	101.96					1024.07
2020	0	171.75	207.28	32.30	0	511.08	156.76					1079.17
YEAR	WM1	WM2	WM3	WM4	WM5	WM6	WM7	WM9	WM10	WM11		WM TOTAL
1997	115.27	390.70	495.13	290.96	194.60	567.41	315.24	379.96	227.40			2976.67
1998	0	88.57	95.38	104.93	207.12	320.02	678.50	161.85	63.31			1719.68
1999	221.36	146.78	514.07	322.69	331.32	438.02	702.74	348.84	279.91			3305.74
2000	334.13	302.45	681.80	325.58	445.31	652.10	556.21	343.03	424.93			4065.55
2001	244.91	429.25	871.26	336.01	215.24	575.46	280.11	176.54	383.61	310.45		3822.85
2002	331.14	312.54	884.15	471.44	272.88	474.09	684.49	469.81	374.98	510.15		4785.68
2003	166.44	149.31	149.31	190.62	45.90	300.88	878.31	988.85	432.37	453.81		3755.77
2004	217.82	171.02	899.52	334.47	119.31	383.31	505.89	356.83	349.89	241.72		3579.76
2005	86.37	33.41	361.71	238.75	62.31	151.66	367.41	433.39	74.13	50.42		1859.56
2006	201.01	248.30	438.80	76.87	171.61	393.35	227.17	386.66	242.54	114.47		2500.78
2007	96.46	362.98	875.46	318.94	191.93	349.49	521.92	460.48	348.87	420.94		3947.46
2008	3.67	143.15	459.22	105.12	26.97	189.86	465.84	351.57	42.94	492.67		2281.00
2009	9.82	9.97	307.21	21.65	4.96	379.07	452.38	371.24	5.49	60.30		1622.07
2010	1.16	38.20	239.68	7.46	1.56	156.51	356.75	406.25	36.09	36.09		1279.75
2011	13.81	8.91	368.74	21.32	9.13	201.26	546.83	216.56	0	122.08		1508.64
2012	0	90.60	926.40	25.45	139.37	443.62	448.62	341.14	106.94	462.79		2984.92
2013	0	56.56	520.08	95.42	35.97	486.61	836.97	288.68	104.99	279.52		2704.82
2014	0	160.47	522.23	117.38	98.02	310.85	365.93	423.45	68.74	507.32		2574.40
2015	0	181.40	287.61	34.12	64.39	477.43	276.13	369.12	54.96	335.50		2080.67
2016	0	14.49	711.64	0	0	487.22	444.64	264.54	40.16	132.16		2094.85
2017	0	13.59	743.31	0	43.82	256.19	258.56	397.33	159.47	213.85		2086.11
2018	0	9.39	447.00	50	43.55	43.55	335.55	373.27	110.01	251.15		1663.03
2019	0	73.98	114.23	30	57.21	391.54	62.95	276.44	92.20	190.79		1289.07
2020	0	58.10	68.06	23	8.09	253.02	139.39	201.25	127.88	214.14		1233.64
TOTAL ALL SOURCES (ACRE-Feet)												
YEAR	AF	YEAR	AF	YEAR	AF	YEAR	AF	YEAR	AF	YEAR	AF	
1997	6402.31	2001	8128.62	2005	4311.18	2009	4363.80	2013	6991.06	2017	5792.34	
1998	4370.83	2002	8786.88	2006	6856.88	2010	3955.28	2014	7290.69	2018	5820.69	
1999	6653.90	2003	7709.66	2007	8504.43	2011	4832.56	2015	5964.19	2019	5248.81	
2000	8491.51	2004	7700.94	2008	5275.46	2012	7449.32	2016	6287.28	2020	5055.11	

Quantities are in MILLION GALLONS converted to ACRE FEET from individual well meters. Totals will not necessarily match cumulative well field master meters due to unknown meter inaccuracies.

8-3 Water Supply Sources and Wells Specific Capacity

LAKE MARY SURFACE WATER PRODUCTION DESIGN CAPACITY		8.0 MGD					
RESERVIOR FILTRATION PLANT (INNER BASIN WATER) CAPACITY		2.0 MGD		2020			
LAKE MARY WELLS (year last modified)	Surface Elevation (feet)	Static Level (feet bls)	Pumping Level (feet bls)	Current yield (gpm)	Current yield (MGD)	Drawdown (feet)	Specific Capacity (gpm/ft)
LM #1, 2002 Pump & Motor	6838	671	DNR	DNR	DNR	DNR	DNR
LM #2, 2008 Pump & Motor	6837	598	894	360	0.52	296	1.2
LM #4, 2009 Pump & Motor	6809	561	777	400	0.58	216	1.9
LM #5, 2011 Pump & Motor	6816	523	625	290	0.42	102	2.8
LM #8, 2016 Pump & Motor	6818	578	717	380	0.55	139	2.7
LM #9, 2009 Pump & Motor	6875	353	718	240	0.35	365	0.7
MAXIMUM YIELD FOR WELLFIELD (MGD)	3.0	3.00					
WOODY MTN. WELLS (year last modified)	Surface Elevation	Static Level	Pumping Level	Current yield	Current yield	Drawdown	Specific Capacity
WM #1, 2005 Pump & Motor	7137	1252	DNR	DNR	DNR	DNR	DNR
WM #2, 2020 Pump & Motor	7167	BAD	BAD	245	0.35	BAD	BAD
WM #3, 2015 Pump & Motor	7129	1213	1298	570	0.82	85	6.7
WM #4, 2018 Pump & Motor	7163	1108	1299	320	0.46	191	1.7
WM #5, 2019 Pump & Motor	7186	1103	1249	280	0.40	146	1.9
WM #6, 2004 Pump & Motor	7201	1079	1340	405	0.58	261	1.6
WM #7, 2009 Pump & Motor	7171	1124	1262	550	0.79	138	4.0
WM #9, 2014 Pump & Motor	7088	997	1375	400	0.58	378	1.1
WM #10, 2017 Pump & Motor	7240	1177	1348	280	0.40	171	1.6
WM #11, 2011 Pump & Motor	7170	1124	1397	355	0.51	273	1.3
MAXIMUM YIELD FOR WELLFIELD (MGD)	5.1	5.09					
LOCAL WELLS (year last modified)	Surface Elevation	Static Level	Pumping Level	Current yield	Current yield	Drawdown	Specific Capacity
Continental, 2006 Pump & Motor	6751	1315	1467	310	0.45	152	2.0
Foxglenn, 2018 Pump & Motor	6775	1341	1405	300	0.43	64	4.7
Shop, 2017 Pump, 2016 Motor	6799	1467	1679	920	1.33	212	4.3
Sinagua, 2020 Pump & Motor	6770	1293	BAD	275	0.40	BAD	BAD
Ft. Tuthil, 2015 Pump & Motor	7000	1131	1207	1135	1.64	76	14.9
*McAllister, Design Completed 2016	7060	*	*	*	*	*	*
Interchange, 2003 Pump & Motor	6790	1402	1591	240	0.35	189	1.3
Rio, 2006 Pump & Motor	6858	1114	BAD	200	0.29	BAD	BAD
MAXIMUM YIELD FOR WELLFIELD (MGD)	4.8	4.80					

DNR-Well Did Not Run

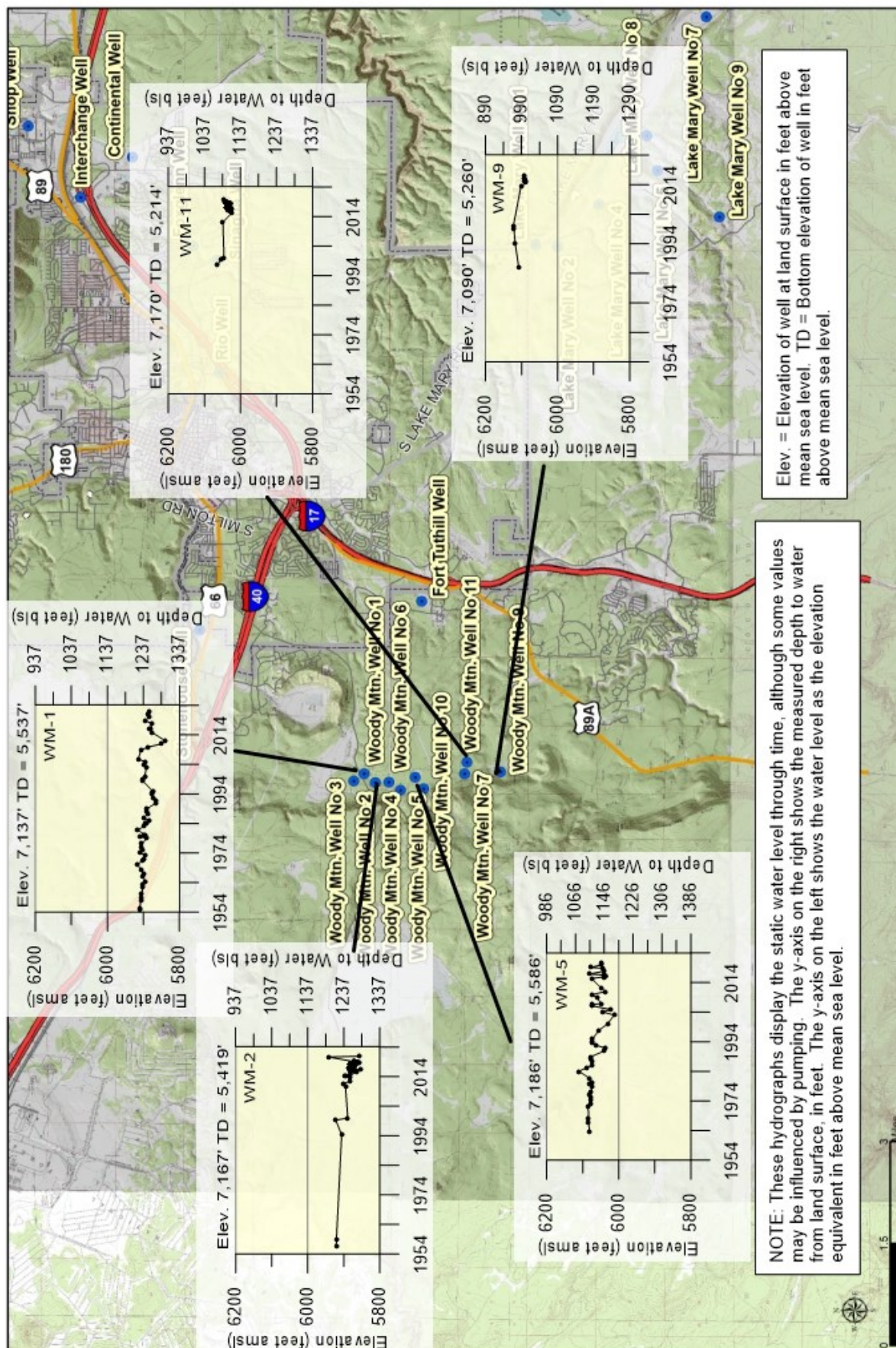
BAD-Transducer or Airline Not Working

All VFD dynamic levels taken on the last day that the VFD was at 100%

Sum of current yield may be different maximum yield for wellfield reported as peak yield on page 5 and page 17

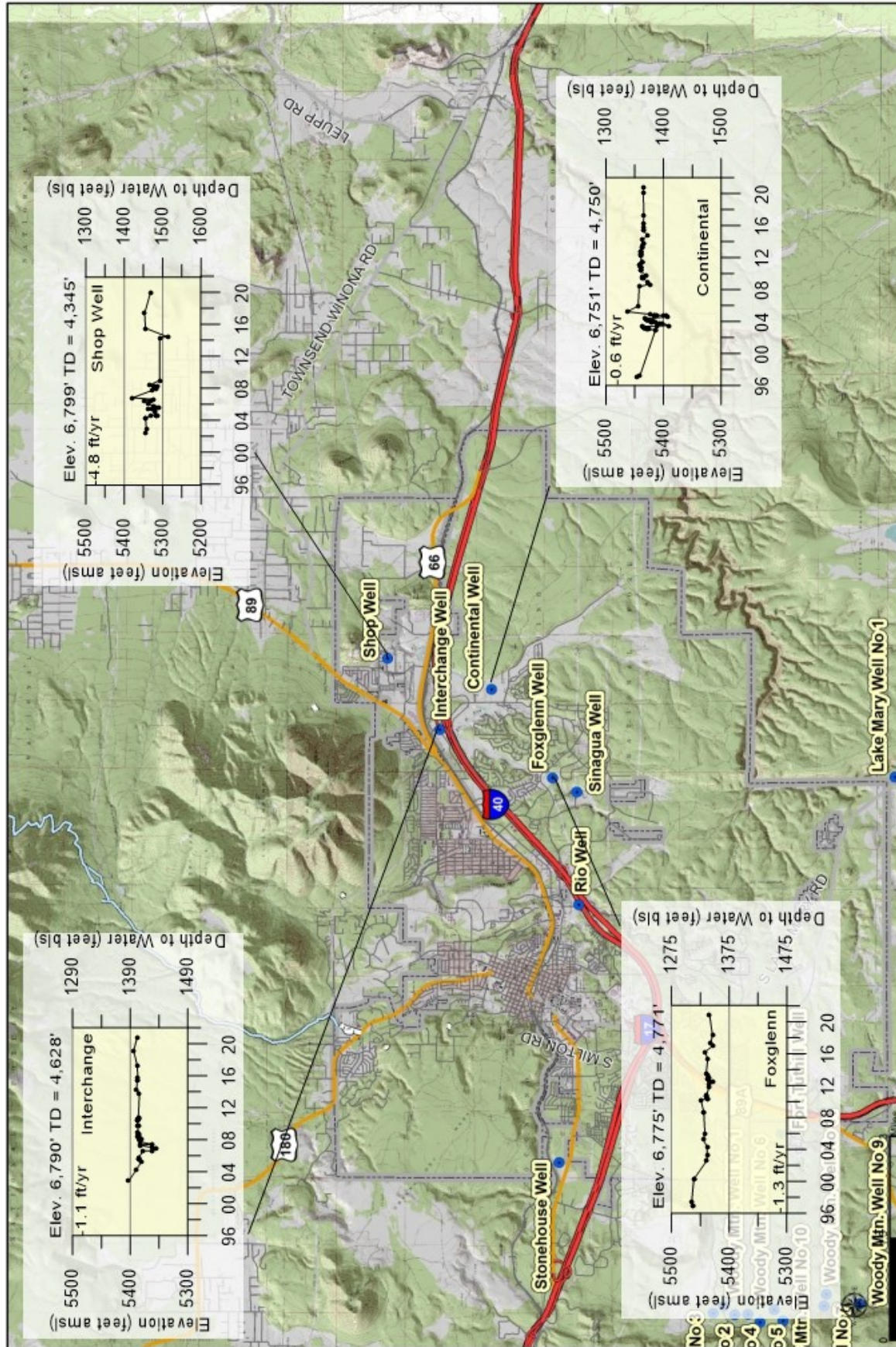
8-4 Water Level Hydrographs

Woody Mountain Wells



8-4 Water Level Hydrographs

Local Wells East

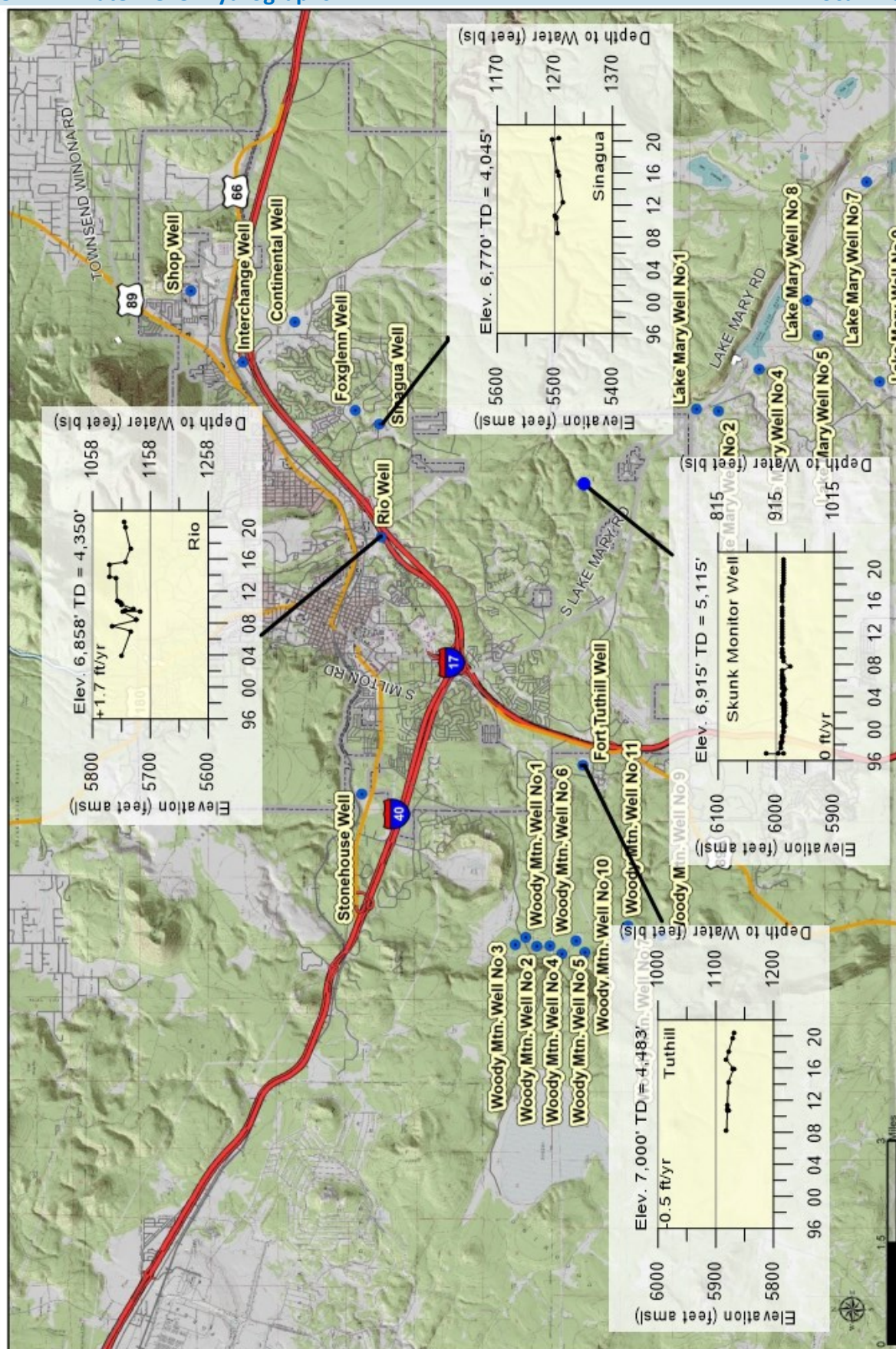


NOTE: These hydrographs display the static water level through time, although some values may be influenced by pumping. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

NOTE: These hydrographs display the static water level through time, although some values may be influenced by pumping. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

8-4 Water Level Hydrographs

Local Wells West

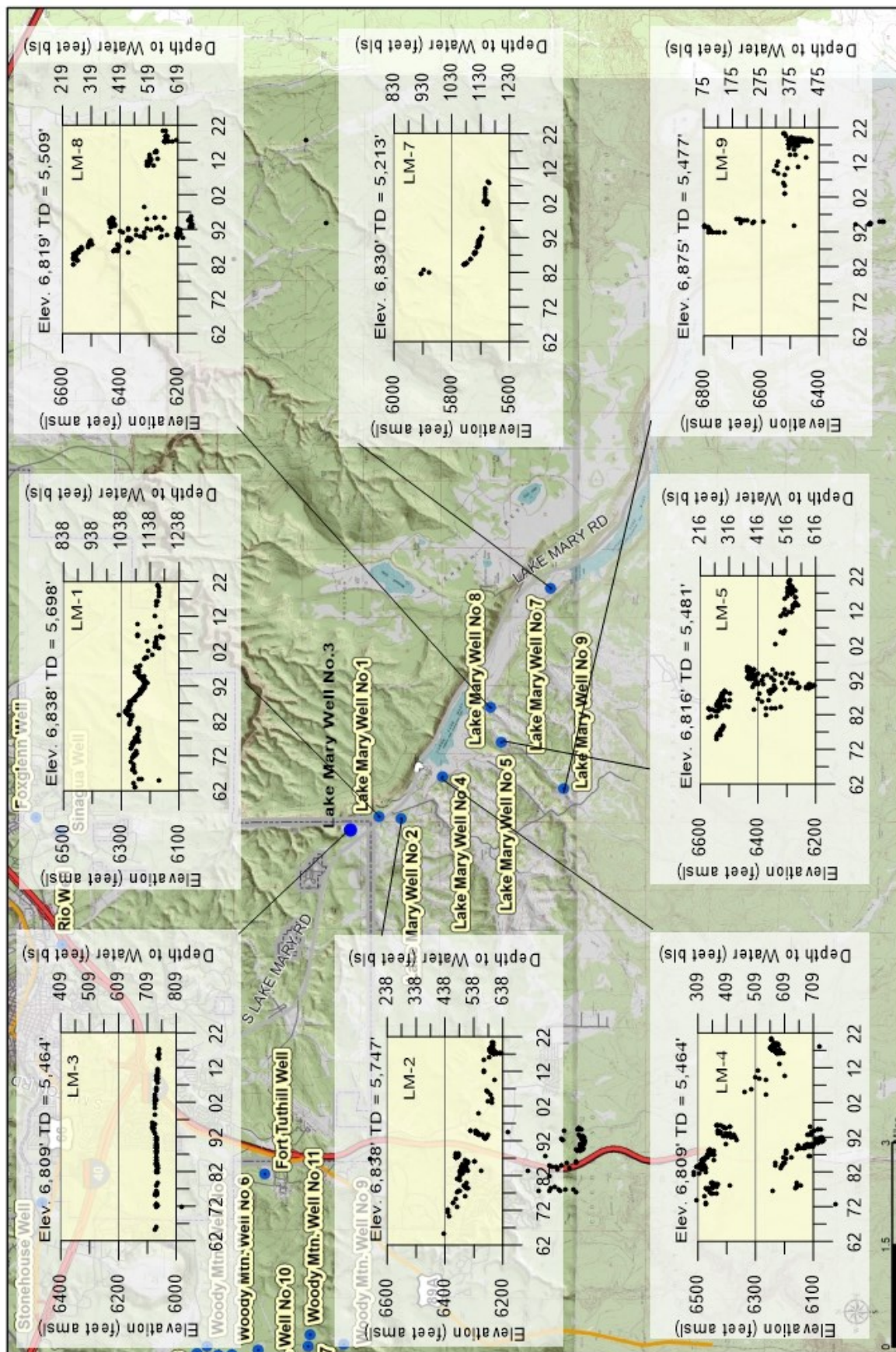


Elev. = Elevation of well at land surface in feet above mean sea level.
TD = Bottom elevation of well in feet above mean sea level.

NOTE: These hydrographs display the static water level through time, although some values may be influenced by pumping. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

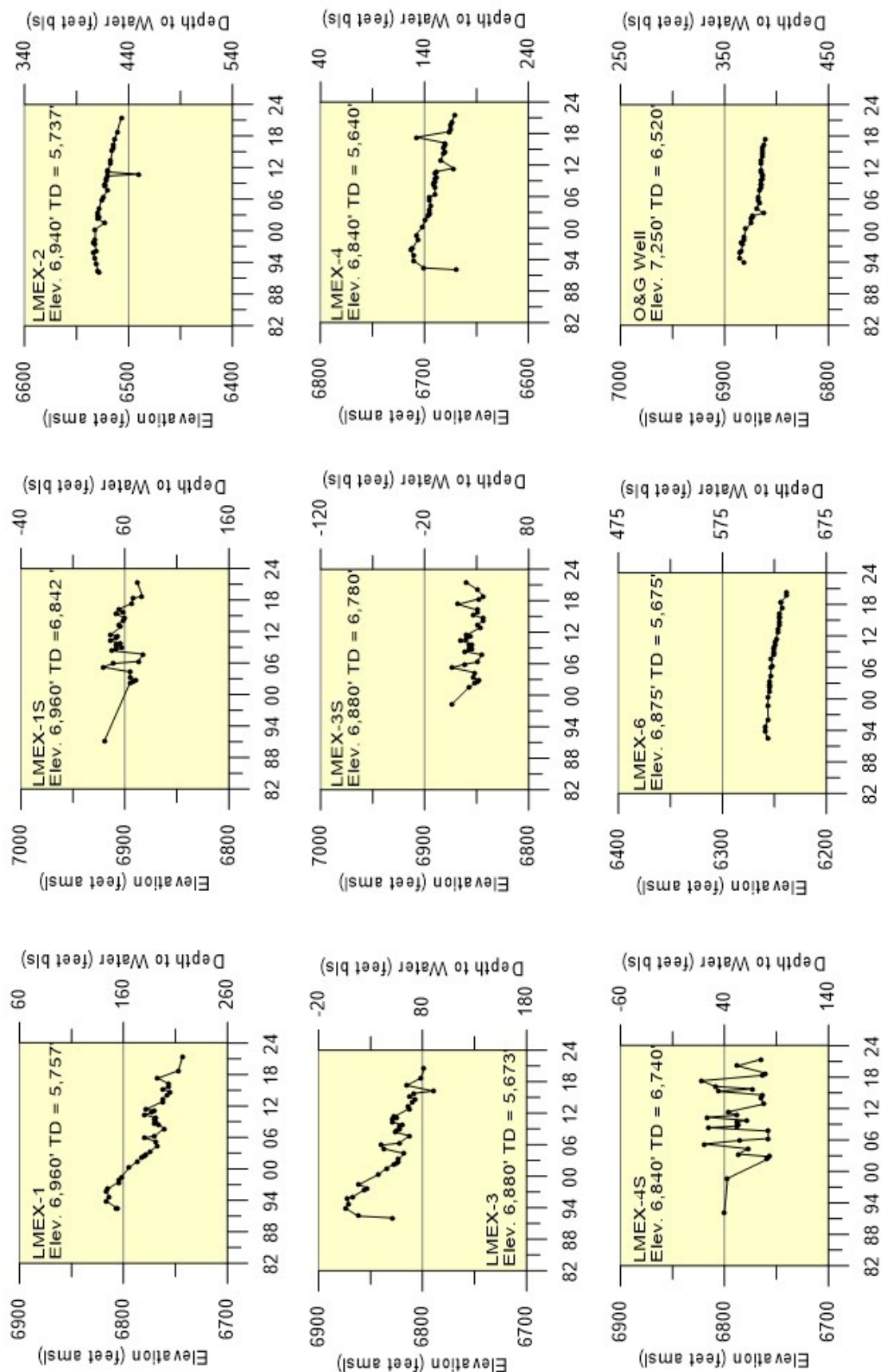
8-4 Water Level Hydrographs

Lake Mary Wells



8-4 Water Level Hydrographs

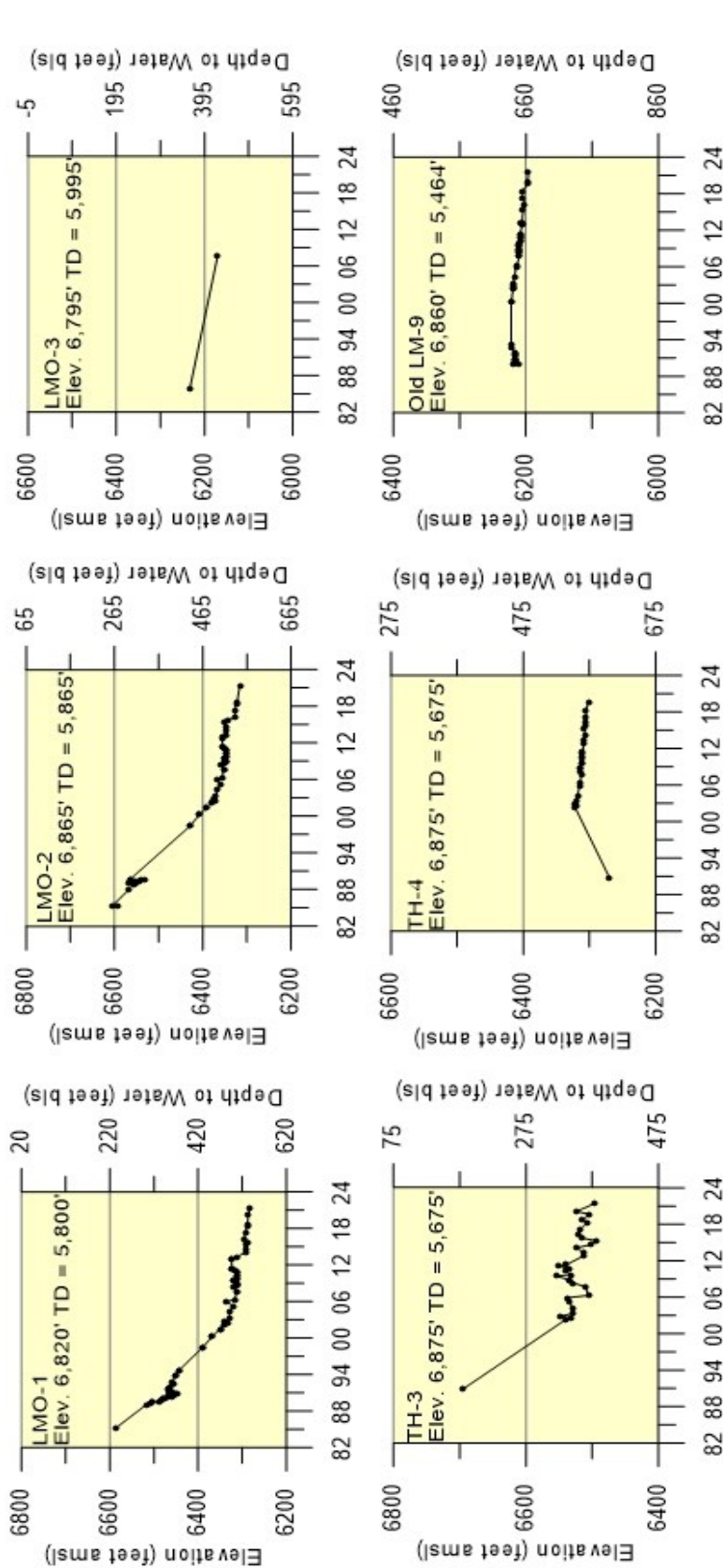
Lake Mary Observation Wells



NOTE: These hydrographs display the static (non-pumping) water level through time. The Elev. = Elevation of well at land surface in feet above mean sea level. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level. TD = Bottom elevation of well in feet above mean sea level.

8-4 Water Level Hydrographs

Lake Mary Observation Wells (continued)



NOTE: These hydrographs display the static (non-pumping) water level through time. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

Elev. = Elevation of well at land surface in feet above mean sea level.
TD = Bottom elevation of well in feet above mean sea level.

9

UPPER LAKE MARY WATERSHED

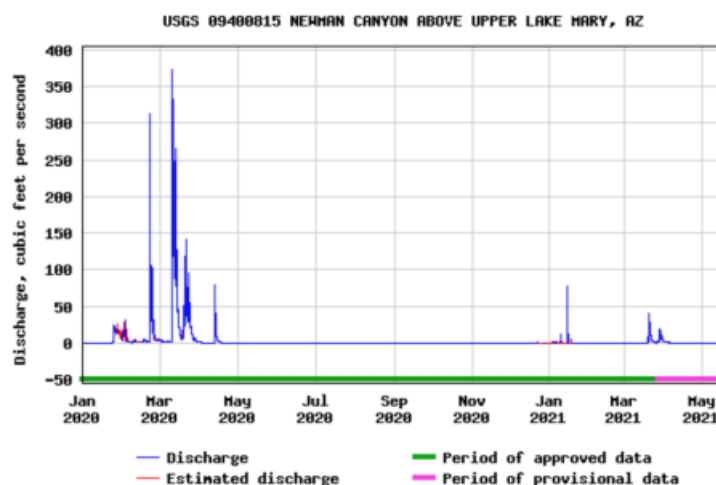
9-1 Upper Lake Mary Monitoring at Newman Canyon—2020 Summary

The Water Services Division, Flagstaff Watershed Protection Project & the Lake Mary—Walnut Canyon Technical Advisory Committee partnered with the US Geological Survey to install a stream flow gage and sediment sampler in Newman Canyon in 2014. Newman Canyon is the largest tributary to Upper Lake Mary. Sediment data are available at <http://cida.usgs.gov/sediment/> and stream gage data are available at <http://waterdata.usgs.gov/nwis/rt> Stream Gage 09400815. A turbidity sensor was added to the site in January, 2020.

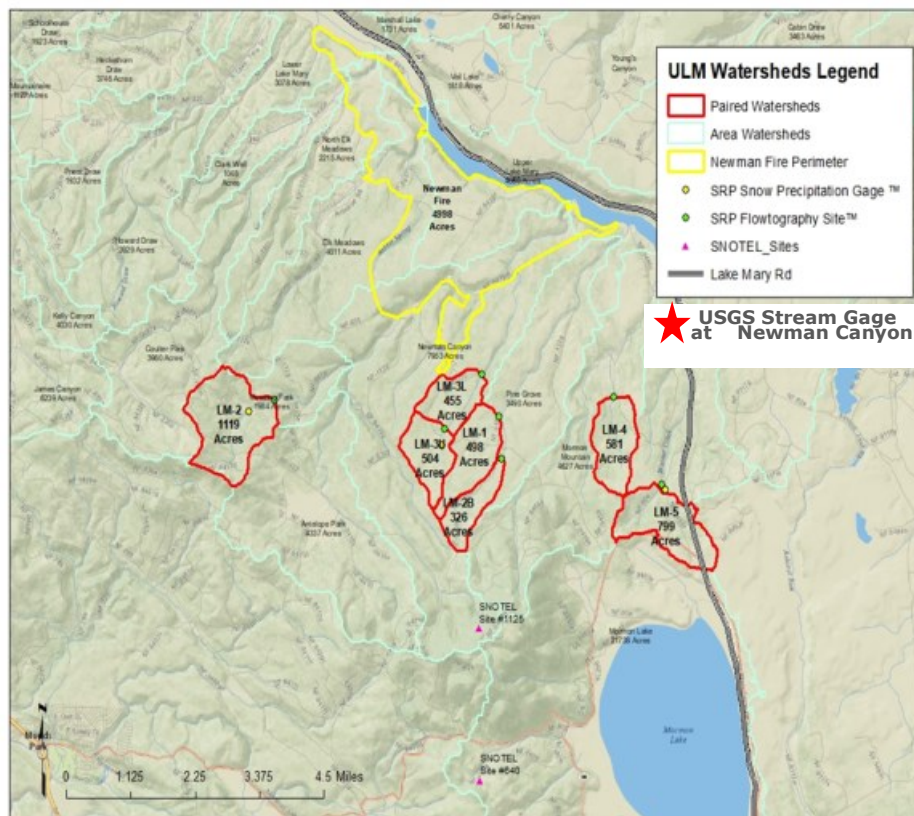
The lake came up from 60% in November, 2019 to 90 percent full coming into 2020. The lake was 45% full coming into 2021 after water production processed 3,183 acre-feet of water in the 2020 calendar year.

Discharge, cubic feet per second

Most recent instantaneous value: 0.00 05-17-2021 23:00 MST



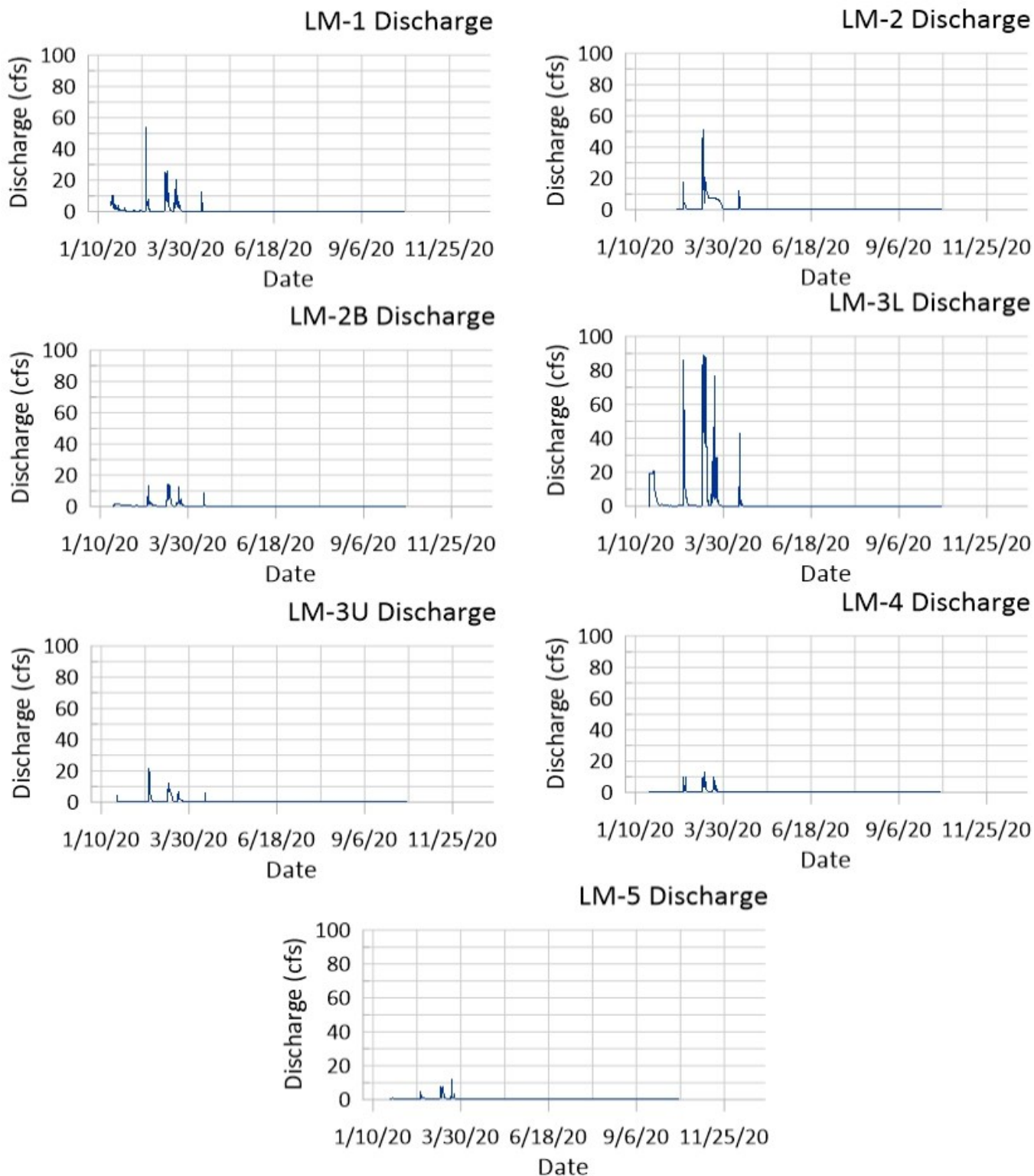
9-2 Upper Lake Mary Watershed Monitoring Program Instrumentation Sites



In 2013, Northern Arizona University & the Rocky Mountain Research Station (RMRS) presented a Paired Watershed Study to the Lake Mary-Walnut Canyon Technical Advisory Committee (TAC). The TAC agreed the project was important to begin prior to FWPP and 4FRI thinning projects as useful baseline information. TAC agreed to purchase the flowtopography equipment and funded a U.S. Geological Survey streamflow gauge and sediment sampler in Newman Canyon. The three parties (City of Flagstaff, Forest Service, Park Service) approved the recommended action and the equipment was purchased and installed.

At this time, seven sub-watersheds of the ULM watershed have sites instrument-

ed with SRP Flowtopgraphy (TM) Stations and a pressure transducer and three of those subwatersheds are equipped with a precipitation and snow gauge. Each flowtopgraphy station captures a photo every 15 minutes focused on a graduated vertical stake of rebar placed in the center of the drainage. When runoff events occur, the photo captures the height of water against the graduated rebar. Each height corresponds to a table of estimated flow rates which provides an estimate of total volume per event. Streamflow and volume data are compared with precipitation data to establish a rainfall-runoff relationship for the contributing watersheds. Stage converted to discharge is shown below for the five Flowtopgraphy™ sites.



9-3 Upper Lake Mary Response to Climate Variability

The University of Arizona Climate Assessment for the Southwest (CLIMAS) group produced a report for the Water Resources Section in early 2020. The purpose of the report was to analyze long term lake levels in comparison to water production and climate variability to see if there is a correlation between lake levels and climate change. The report found no statistical significance between lake levels and climate (precipitation, snow water equivalent, and air temperature). However, the Upper Lake Mary watershed is experiencing hotter temperatures that may lead to great evapotranspiration and reservoir water losses in the future.

Analyses of unusual years in terms of low or high lake level years were also completed. Maximum lake level years (shown in blue below) matched very well with high winter precipitation years (marked in bold in column three). Cool season precipitation, therefore, is important for maintaining lake levels, this is troubling due to the increase in air temperature and the anticipated loss of snow fall events (to rain only events) due to climate change.

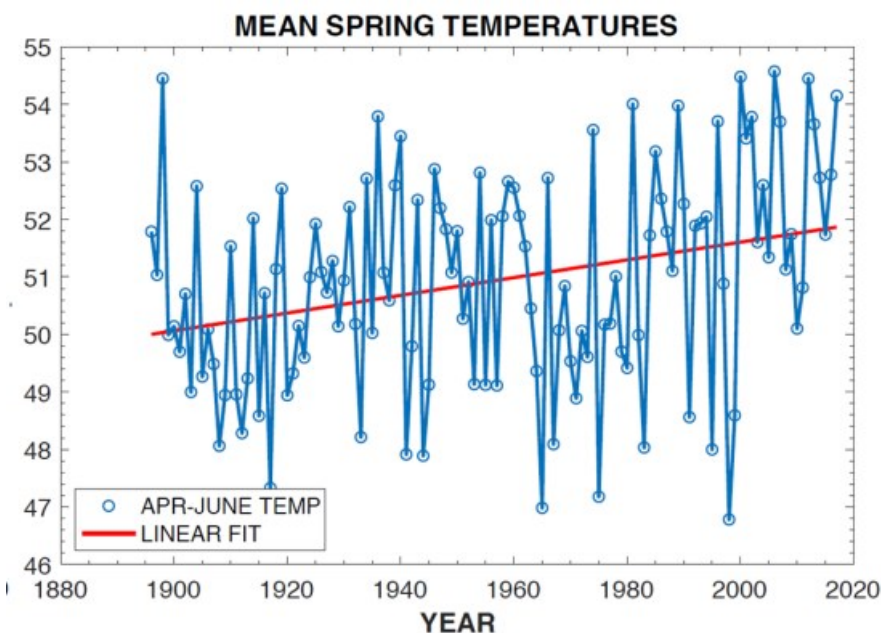
Upper Lake Mary (ULM) Stats – 1960 to 2018	
Maximum Possible Volume	16,300 acre feet (100% full)
Maximum Lake Level Mean	10,459 acre feet (64% full)
Minimum Lake Level Mean (production included)	4,902 acre feet (30% full)
Minimum Lake Level Mean (no production)	7,489 acre feet (46% full)
Absolute Minimum Lake Level (production included)	374 acre feet (2.3% full in 1978)
Absolute Minimum Lake Level (no production)	71,614 acre feet (9.9% full in 2003)
Years ULM has reached Max Possible Volume	15 years (100% full at highest spring levels)

Results from trend analysis, a p-value less than 0.05 is considered statistically significant.

Variable	Time Period	Slope	P-value	Significant?
Minimum ULM Levels (no production)	1960-2018	-0.04	0.82	No
Maximum ULM Levels	1960-2018	-0.07	0.76	No
Total Annual WY Precip (Oct-Sep)	1896-2017	0.0003	0.8	No
Total Cool Season Precip (Nov-Mar)	1896-2017	0.004	0.74	No
Fort Valley March 1 SWE	1947-2018	-0.01	0.7	No
Mean Annual WY Temp	1896-2017	0.01	<0.01	Yes
Mean Spring (Apr-Jun) Temp	1896-2017	0.02	<0.01	Yes

9-3 Upper Lake Mary Response to Climate Variability

Mean spring temperatures show a statistically significant trend towards warmer temperatures.



“WY” = WATER YEAR, THE TWO COLUMNS IN BOLD ARE SHOWN TO HAVE HIGH CORRELATION. “P” = PRECIPITATION

WY	Max Lake Level	Oct P	Nov-Mar P	Apr-May P	SW prod
1966					
1969					
1973					
1978					
1979					
1980					
1982					
1983					
1985					
1993					
1995					
2005					
2008					
2010					
2017					

Citation:

Upper Lake Mary: Lake Level Response to Climate Variability, Anderson, Talia, Woodhouse, C., Ferguson, D., 2020. Report to Flagstaff Water Services. School of Geography, Development, and the Environment; Laboratory of Tree Ring Research, University of Arizona. Climate Assessment for the Southwest; Institute of the Environment, University of Arizona.

9-4 Upper Lake Mary Monthly Water Level History, Jan 1960—Dec 2020

LAKE % FULL	January	February	March	April	May	June	July	August	September	October	November	December
1960	15%	13%	12%	47%	43%	38%	34%	28%	26%	23%	21%	19%
1961	17%	16%	15%	22%	21%	17%	14%	13%	11%	9%	8%	7%
1962	6%	6%	35%	66%	68%	62%	55%	49%	43%	39%	35%	32%
1963	30%	28%	26%	23%	21%	18%	15%	12%	12%	10%	8%	7%
1964	7%	5%	5%	11%	24%	21%	17%	16%	14%	12%	10%	9%
1965	8%	21%	25%	43%	85%	81%	71%	67%	62%	56%	52%	79%
1966	100%	100%	99%	100%	97%	87%	80%	72%	65%	59%	53%	50%
1967	100%	95%	89%	84%	81%	74%	65%	64%	61%	55%	50%	46%
1968	44%	41%	62%	91%	99%	86%	78%	72%	66%	61%	56%	50%
1969	48%	86%	84%	100%	97%	88%	81%	75%	70%	65%	59%	56%
1970	52%	47%	46%	55%	57%	49%	43%	39%	35%	45%	39%	36%
1971	33%	29%	27%	26%	22%	18%	14%	11%	11%	9%	11%	10%
1972	38%	35%	33%	29%	26%	22%	20%	17%	16%	15%	64%	65%
1973	69%	66%	69%	87%	100%	99%	87%	82%	74%	66%	61%	55%
1974	51%	49%	45%	45%	40%	32%	25%	22%	18%	14%	12%	9%
1975	7%	5%	8%	24%	38%	34%	30%	28%	24%	22%	18%	16%
1976	14%	10%	33%	49%	62%	59%	51%	46%	40%	37%	33%	29%
1977	26%	24%	22%	19%	17%	14%	11%	8%	5%	3%	3%	3%
1978	2%	3%	57%	100%	96%	88%	77%	71%	65%	58%	54%	65%
1979	100%	97%	93%	100%	100%	95%	84%	76%	67%	60%	55%	51%
1980	48%	54%	100%	100%	100%	92%	84%	77%	67%	61%	55%	51%
1981	47%	42%	38%	38%	39%	33%	28%	23%	20%	18%	15%	13%
1982	12%	13%	40%	100%	96%	87%	78%	70%	66%	62%	56%	67%
1983	84%	83%	100%	100%	100%	94%	85%	79%	73%	82%	79%	76%
1984	91%	90%	85%	80%	74%	68%	59%	54%	51%	46%	43%	39%
1985	43%	41%	51%	100%	100%	92%	78%	70%	62%	59%	58%	60%
1986	57%	66%	84%	78%	71%	63%	57%	54%	52%	59%	53%	49%
1987	46%	57%	85%	87%	81%	71%	62%	56%	51%	45%	46%	43%
1988	38%	48%	50%	61%	54%	46%	39%	34%	31%	25%	23%	22%
1989	21%	26%	34%	32%	31%	23%	21%	20%	18%	17%	15%	15%
1990	15%	15%	19%	18%	17%	14%	14%	13%	13%	12%	12%	12%
1991	12%	14%	29%	52%	61%	54%	47%	40%	33%	29%	25%	21%
1992	21%	21%	42%	68%	66%	63%	56%	50%	48%	41%	38%	37%
1993	62%	100%	100%	100%	95%	87%	80%	71%	67%	59%	54%	53%
1994	49%	44%	46%	56%	58%	53%	43%	37%	33%	29%	26%	25%
1995	25%	25%	100%	97%	97%	91%	82%	75%	70%	66%	62%	56%
1996	54%	50%	46%	41%	36%	30%	26%	25%	23%	21%	20%	19%
1997	18%	23%	25%	45%	49%	44%	38%	33%	30%	28%	25%	23%
1998	22%	26%	21%	70%	91%	83%	73%	67%	57%	55%	51%	46%
1999	43%	40%	38%	37%	37%	34%	32%	30%	29%	40%	36%	33%
2000	30%	29%	49%	33%	32%	26%	22%	21%	18%	19%	19%	19%
2001	16%	16%	18%	38%	38%	34%	30%	27%	25%	24%	23%	22%
2002	19%	18%	17%	17%	15%	13%	11%	11%	9%	9%	9%	9%
2003	9%	9%	22%	39%	34%	32%	28%	28%	28%	27%	26%	26%
2004	26%	26%	26%	40%	37%	33%	28%	26%	25%	24%	23%	29%
2005	64%	100%	100%	100%	99%	91%	84%	76%	72%	67%	63%	58%
2006	54%	51%	48%	47%	44%	39%	35%	32%	30%	27%	25%	23%
2007	22%	22%	21%	21%	19%	17%	15%	14%	13%	12%	11%	12%
2008	25%	39%	55%	100%	98%	85%	76%	73%	70%	65%	62%	59%
2009	57%	56%	71%	75%	69%	62%	54%	49%	42%	38%	35%	32%
2010	30%	31%	32%	86%	99%	90%	82%	77%	70%	64%	59%	54%
2011	49%	53%	65%	61%	53%	46%	41%	36%	33%	31%	30%	29%
2012	28%	27%	30%	36%	32%	27%	24%	23%	22%	20%	19%	18%
2013	21%	29%	40%	41%	36%	31%	28%	27%	24%	33%	32%	31%
2014	30%	28%	41%	39%	36%	31%	28%	27%	27%	26%	24%	23%
2015	24%	32%	66%	66%	62%	57%	52%	48%	44%	42%	42%	43%
2016	42%	48%	55%	51%	50%	46%	41%	39%	36%	33%	31%	33%
2017	57%	82%	102%	98%	92%	82%	79%	75%	70%	66%	62%	58%
2018	55%	53%	50%	46%	42%	36%	33%	30%	27%	25%	24%	22%
2019	23%	55%	102%	98%	87%	80%	74%	69%	67%	64%	61%	68%
2020	67%	67%	82%	88%	83%	76%	68%	64%	57%	52%	49%	45%
Historic Avg	38.1%	41.4%	51.0%	60.6%	60.7%	54.7%	48.6%	44.6%	40.8%	38.4%	36.5%	35.5%
Historic Med	30.4%	34.8%	46.0%	55.4%	58.2%	52.7%	42.5%	39.0%	35.2%	36.8%	34.5%	32.5%

9-5 Upper Lake Mary Inflow Report & Predicted Water Budget 1960-2020

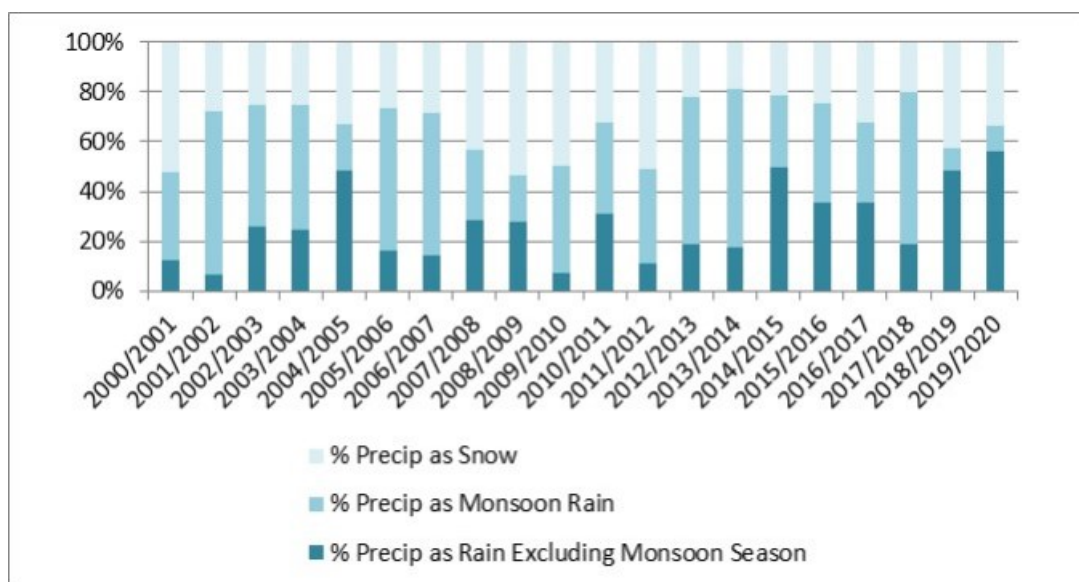
YEAR	LOWEST LEVEL OCT- APRIL	DATE	HIGHEST LEVEL SPRING	DATE	RUN-OFF GAIN	TOTAL YEARLY LOSS %	SURFACE WATER PROD (MG)	SW PROD LOSS OF LAKE	EVAP LOSS OF LAKE	CALENDAR YR PRECIP INCHES	SNOW SEASON, OCT- APRIL
1960	11.1%	3/4/1960	46.4%	4/1/1960	35.3%	-32.9%	568.72	-11.17%	-21.73%	16.60	77.60
1961	13.5%	3/3/1961	21.8%	4/7/1961	8.3%	-16.6%	527.43	-10.36%	-6.24%	18.95	53.90
1962	5.2%	2/2/1962	66.9%	5/4/1962	61.7%	-39.3%	495.11	-9.73%	-29.57%	18.00	128.90
1963	27.6%	2/1/1963	27.6%	2/1/1963	0.0%	-23.7%	542.01	-10.65%	-13.05%	14.52	46.20
1964	3.9%	3/6/1964	23.5%	5/1/1964	19.6%	-15.8%	424.81	-8.34%	-7.46%	19.04	89.40
1965	7.7%	1/1/1965	82.1%	5/7/1965	74.4%	-30.8%	558.35	-10.97%	-19.83%	36.59	166.70
1966	51.3%	11/5/1965	100.0%	4/1/1966	48.7%	-51.0%	769.46	-15.11%	-35.89%	20.58	83.40
1967	49.0%	12/2/1966	95.6%	1/6/1967	46.6%	-54.8%	947.19	-18.61%	-36.19%	22.27	63.10
1968	40.8%	2/2/1968	94.5%	5/3/1968	53.7%	-46.4%	973.82	-19.13%	-27.27%	16.53	150.40
1969	48.1%	1/3/1969	100.0%	4/4/1969	51.9%	-53.6%	866.99	-17.03%	-36.57%	23.41	134.70
1970	46.4%	3/6/1970	56.8%	5/1/1970	10.4%	-27.5%	1044.86	-20.52%	-6.98%	24.02	95.70
1971	29.3%	2/5/1971	29.3%	2/5/1971	0.0%	-19.1%	847.34	-16.64%	-2.46%	21.01	56.60
1972	10.2%	12/3/1971	37.6%	1/7/1972	27.4%	-22.6%	636.40	-12.50%	-10.10%	24.67	50.30
1973	15.0%	10/6/1972	100.0%	5/4/1973	85.0%	-51.4%	1171.30	-23.01%	-28.39%	19.71	210.00
1974	48.6%	2/1/1974	48.6%	2/1/1974	0.0%	-43.6%	1303.22	-25.60%	-18.00%	17.41	70.00
1975	5.0%	2/7/1975	37.6%	5/2/1975	32.6%	-27.4%	720.08	-14.14%	-13.26%	20.10	141.10
1976	10.2%	2/6/1976	62.5%	5/7/1976	52.3%	-39.0%	1113.08	-21.86%	-17.14%	20.12	131.60
1977	23.5%	2/4/1977	23.5%	2/4/1977	0.0%	-21.2%	849.49	-16.69%	-4.51%	18.77	70.20
1978	2.3%	1/6/1978	100.0%	4/7/1978	97.7%	-46.0%	897.60	-17.63%	-28.37%	30.72	116.30
1979	54.0%	11/3/1978	100.0%	5/4/1979	46.0%	-52.3%	1232.64	-24.21%	-28.09%	19.68	145.50
1980	47.7%	1/4/1980	100.0%	5/2/1980	52.3%	-61.6%	1259.06	-24.73%	-36.87%	29.30	177.10
1981	38.4%	3/6/1981	38.7%	5/1/1981	0.3%	-26.2%	1078.16	-21.18%	-5.02%	23.37	92.40
1982	12.5%	1/8/1982	100.0%	4/2/1982	87.5%	-44.1%	1230.27	-24.17%	-19.93%	31.09	121.60
1983	55.9%	11/5/1982	100.0%	5/6/1983	44.1%	-24.0%	942.45	-18.51%	-5.49%	29.47	142.60
1984	76.0%	12/2/1983	90.7%	1/6/1984	14.7%	-52.0%	902.66	-17.73%	-34.27%	20.09	32.00
1985	38.7%	12/7/1984	100.0%	5/3/1985	61.3%	-43.2%	1479.67	-29.06%	-14.14%	26.67	136.00
1986	56.8%	1/24/1986	84.2%	3/28/1986	27.4%	-38.3%	1380.27	-27.11%	-11.19%	32.39	105.40
1987	45.9%	1/30/1987	86.9%	4/25/1987	41.0%	-49.3%	1857.80	-36.49%	-12.81%	23.98	121.60
1988	37.6%	1/24/1988	61.0%	4/28/1988	23.4%	-40.3%	1789.80	-35.16%	-5.14%	21.68	104.50
1989	20.7%	2/23/1989	34.8%	3/30/1989	14.1%	-19.6%	116.00	-2.28%	-17.32%	14.44	77.70
1990	15.2%	1/11/1990	19.2%	3/29/1990	4.0%	-7.1%	33.00	-0.65%	-6.45%	25.67	113.40
1991	12.1%	12/5/1990	63.4%	4/11/1991	51.3%	-42.4%	1144.50	-22.48%	-19.92%	21.83	127.90
1992	21.0%	1/30/1992	70.3%	4/9/1992	49.3%	-33.5%	981.60	-19.28%	-14.22%	34.71	158.90
1993	36.8%	12/28/1992	100.0%	4/15/1993	63.2%	-54.9%	1345.90	-26.44%	-28.46%	35.60	149.70
1994	45.1%	2/24/1994	58.7%	5/1/1994	13.6%	-34.9%	1117.30	-21.95%	-12.95%	21.91	149.20
1995	23.8%	2/12/1995	100.0%	4/27/1995	76.2%	-51.4%	1107.90	-21.76%	-29.64%	17.79	99.10
1996	48.6%	2/8/1996	48.6%	2/8/1996	0.0%	-30.2%	619.25	-12.16%	-18.04%	11.81	28.50
1997	18.4%	1/1/1997	51.8%	4/17/1997	33.4%	-30.9%	581.33	-11.42%	-19.48%	15.61	107.50
1998	20.9%	2/19/1998	90.7%	4/27/1998	69.8%	-53.5%	1095.90	-21.53%	-31.97%	27.30	136.70
1999	37.2%	4/1/1999	41.6%	4/15/1999	4.4%	-13.8%	386.62	-7.59%	-6.21%	15.72	72.00
2000	27.8%	9/9/1999	34.8%	4/4/2000	7.0%	-19.1%	255.77	-5.0%	-14.08%	15.38	74.40
2001	15.7%	1/1/2001	38.5%	4/16/2001	22.8%	-21.8%	308.50	-6.1%	-15.74%	17.55	125.10
2002	16.7%	3/30/2002	16.7%	3/30/2002	0.0%	-8.1%	63.76	-1.3%	-6.84%	12.88	38.90
2003	8.6%	2/6/2003	40.4%	3/27/2003	31.8%	-15.7%	200.65	-3.9%	-11.73%	17.85	54.90
2004	24.7%	2/22/2004	40.4%	3/26/2004	15.7%	-18.3%	293.58	-5.8%	-12.53%	23.61	48.10
2005	22.1%	10/20/2004	100.0%	4/7/2005	77.9%	-48.7%	1195.98	-23.5%	-25.20%	24.01	131.70
2006	51.3%	2/1/2006	51.3%	2/1/2006	0.0%	-30.6%	506.21	-9.9%	-20.66%	15.56	44.60
2007	20.7%	4/1/2007	20.7%	4/1/2007	0.0%	-10.2%	96.03	-1.8%	-8.4%	17.46	50.40
2008	10.5%	11/27/2007	100.0%	3/27/2008	89.47%	-45.7%	954.58	-17.94%	-27.76%	18.85	99.50
2009	54.3%	1/16/2009	76.7%	3/11/2009	22.40%	-47.2%	1220.04	-22.93%	-24.26%	11.65	86.00
2010	29.5%	1/8/2010	101.7%	4/11/2010	72.19%	-51.1%	1299.95	-24.44%	-26.66%	27.89	140.5
2011	50.6%	1/27/2011	65.8%	3/26/2011	15.19%	-38.9%	1113.185	-20.92%	-17.97%	20.67	88.4
2012	26.9%	3/8/2012	37.3%	3/27/2012	10.40%	-19.6%	304.513	-5.72%	-13.88%	14.89	102.9
2013	17.7%	1/16/2013	43.6%	3/21/2013	25.90%	-16.2%	512.476	-9.63%	-6.53%	24.79	69.7
2014	27.4%	2/28/2014	42.3%	3/8/2014	14.85%	-20.3%	338.17	-6.36%	-13.93%	20.67	44.4
2015	22.0%	12/31/2014	69.9%	3/17/2015	47.9%	-28.5%	604.13	-11.36%	-17.14%	27.25	62.9
2016	41.4%	10/9/2015	55.8%	3/3/2016	14.4%	-26.8%	529.53	-9.95%	-16.88%	25.8	78.3
2017	29.0%	12/16/2016	100.0%	4/6/2017	71.0%	-45.0%	580.86	-10.92%	-34.08%	18.00	96.5
2018	55.0%	4/19/2018	55.0%	4/19/2018	0.0%	-33.4%	694.63	-13.06%	-20.34%	21.58	38.0
2019	21.6%	1/10/2019	100.0%	3/7/2019	78.4%	-40.0%	734.99	-13.82%	-26.18%	26.1	118.7
2020	60.0%	11/19/2019	90.0%	3/31/2020	30.0%	-49.8%	1037.04	-19.49%	-30.28%	9.59	70.3
2021	40.2%	3/18/2021	41.0%	4/1/2021	0.8%	-10.7%	450				94.13
2022	27.0%										
Historic Average %	30.4%		64.8%		34.4%	-34.4%	816	-15.9%	-18.6%	22	98
5 yr. average	41%		77%		36%	-36%	715.41	-13%	-26%	20.21	83.53

Evaporation accounts for ~50% of total loss
Bold=low level occurred in fall of previous year

Cells highlighted in red are projected values used to determine approximate evaporation loss for coming year.
 Stats on precip and snow amount are through May 2021 from the National Weather Service NOAA Online Weather Data for Flagstaff Area. Surface water production is in million gallons.

9-6 Precipitation Trends

Water Services is interested in snowpack and summer precipitation patterns to inform our understanding of how precipitation in general influences aquifer recharge and overland runoff into Upper Lake Mary. The graph below shows the water-year precipitation received as a rain to snow relationship for the past 20 years. Water years 18-19 and 19-20 were record setting dry monsoon years (the “non-soon”). As indicated in the bar graph, very little precipitation was received as rain during monsoon season. Water Services will incorporate these and other climate data and projections into its next Water Resources Master Plan. Data converted to determine rain/snow ratio assumes 1" of rain is equal to 12" of snow. The period of annual average is based on the 30 year average yearly records from 1981-2010 (NOAA Technical Memorandum NWS WR-273).



Annual Average	NWS Snow (inches)	NWS Monsoon Rainfall (inches)	NWS Total Precip (inches)	Non-Monsoon Rain converted (calculated)	Total Rain converted (inches)	Snow as precip converted (inches)	% Precip as Rain Excluding Monsoon Season	% Precip as Snow	% Precip as Monsoon Rain
2019/2020	70.30	1.78	17.31	9.67	11.45	5.86	56%	34%	10%
2018/2019	118.70	2.08	23.17	11.20	13.28	9.89	48%	43%	9%
2017/2018	38.00	9.59	15.67	2.91	12.50	3.17	19%	20%	61%
2016/2017	96.50	8.19	25.07	8.84	17.03	8.04	35%	32%	33%
2015/2016	78.30	10.47	26.31	9.32	19.79	6.53	35%	25%	40%
2014/2015	62.90	7.06	24.42	12.13	19.18	5.24	50%	21%	29%
2013/2014	44.4	12.73	19.98	3.55	16.28	3.70	18%	19%	64%
2012/2013	69.7	15.67	26.39	4.91	20.58	5.81	19%	22%	59%
2011/2012	102.9	6.3	16.73	1.86	8.16	8.58	11%	51%	38%
2010/2011	88.4	8.43	22.82	7.02	15.45	7.37	31%	32%	37%
2009/2010	140.5	10.29	23.71	1.71	12.00	11.71	7%	49%	43%
2008/2009	86	2.51	13.38	3.70	6.21	7.17	28%	54%	19%
2007/2008	99.5	5.44	19.27	5.54	10.98	8.29	29%	43%	28%
2006/2007	50.4	8.32	14.59	2.07	10.39	4.20	14%	29%	57%
2005/2006	44.6	8.14	14.14	2.28	10.42	3.72	16%	26%	58%
2004/2005	131.7	6.38	33.49	16.14	22.52	10.98	48%	33%	19%
2003/2004	48.1	7.94	15.9	3.95	11.89	4.01	25%	25%	50%
2002/2003	54.9	9.05	18.33	4.71	13.76	4.58	26%	25%	49%
2001/2002	38.9	7.61	11.63	0.78	8.39	3.24	7%	28%	65%
2000/2001	125.1	6.94	19.88	2.52	9.46	10.43	13%	52%	35%

10

WATER CONSERVATION

10-1 Program Overview & 2020 in Review

Water Conservation, as a public-facing operation, was more affected by the Coronavirus pandemic than many of the other Water Services operations. When the pandemic began in March of 2020, planning was already close to complete for the annual Water Awareness Month campaign. Staff worked hard to pivot their efforts to a virtual campaign that was rebranded *WAM on the Wire*. This approach shifted the majority of the educational outreach efforts onto social media platforms Facebook and Instagram. Weekly posts included Flagstaff water system and watershed facts, promotions of WaterSense content, and trivia questions. Prizes were distributed for some lucky trivia winners, including a WaterSense certified toilet. There were also partnerships with local businesses to distribute Water Conservation branded Kleen Kanteen metal cups at twelve downtown Flagstaff businesses that were providing carry-out service during the early pandemic. Staff also implemented an online art contest, with three categories: Professional, Amateur, and Youth. Each category received submissions, and winners received gift cards to several Flagstaff businesses.



Water Conservation Team from left to right: Kate Miele, Erin Young, Cara Corbin, Mary Samar, Rae Kursky. Not pictured: Tamara Lawless



2020 Water Awareness Month Art Contest submissions. From left to right: An original Navajo weaving by Tyrrell Tapaha, titled "Flow" won first place in the professional category. "Water Makes a Difference," a crayon drawing by Corey Hanson, won first place in the youth category. "Earth's Medicine," an acrylic on canvas by Lani Weis won first place in the amateur category.



WATER RESOURCES
& CONSERVATION

On September 23, 2020 the Alliance for Water Efficiency (AWE) added the City of Flagstaff, Arizona to the AWE G480 Leaderboard. Flagstaff has earned a place among the nation's water conservation leaders by receiving a Gold level of recognition. The City of Flagstaff Water Services Division is the first and only Arizona water utility on the leaderboard.

10-1 Program Overview and 2020 in Review (continued)

The pursuit of this recognition is a component of the Water Conservation Program's Strategic Plan, which was approved by the Flagstaff City Council on December 1st 2020. The plan supports the previous goal of the Flagstaff City Council to become a national leader in water conservation. Flagstaff would not be eligible for the Leaderboard if not for the direction and support provided by Flagstaff City Councils for the past 20 years. In the case of this award, all ten standards require continued financial investment, staff resources, or both. Many of the standards Flagstaff has had in place for 20 years. Recognition by the Alliance for Water Efficiency is one way to demonstrate to the community that Flagstaff is making sound investments in water resources.

The U.S. Environmental Protection Agency recognized the City of Flagstaff Water Conservation program with a 2020 WaterSense Excellence Award for promoting WaterSense and water efficiency in 2019. The Water Conservation Program implemented thousands of fixture replacements in 2019. One of the biggest contributions to the Water Conservation Program's success in getting WaterSense certified fixtures installed throughout the community was a



partnership with Bella Investment Group, a local property management service that runs many multifamily housing complexes in Flagstaff. Bella Investment Group made use of the Commercial Rebate Program to

assist in the replacement 1,061 toilets, 1,557 showerheads, and 3,018 aerators with efficient WaterSense approved models across 6 of their apartment complexes. The replacement fixtures exceeded Flagstaff's plumbing code requirements, with the new toilets ringing in at an ultra-efficient 0.8 gallons per flush. These projects are predicted to save millions of gallons of water over the lifetime of the replaced fixtures.



2020 Rebates

- Residential Toilets – (requiring 1.0 gpm or lower as of 7/1/20) - 66
- Commercial Toilets - 84
- Rainwater Tank – 1
- Low Water Landscape - 1

10-2 Non-Revenue Water—System Leaks



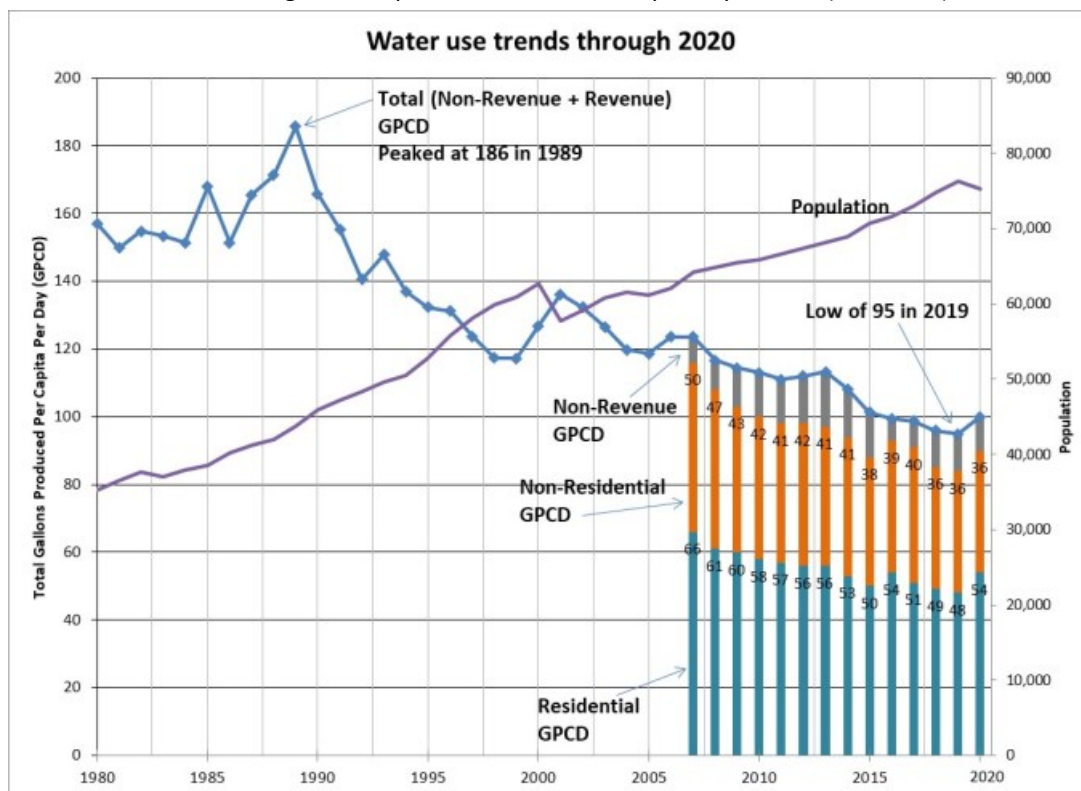
In 2021 Water Services is kicking off an American Water Works Association Non-revenue Water Audit with Cavanaugh consultants. Non-revenue water calculations (such as water produced minus water billed) are only as good as the quality of the data used in the calculation. For example, if water production master meters are rarely calibrated, a utility may be under registering the actual amount of water flowing through the meter. An under registration of actual production could make it look like more water is sold than actual.

The Water Services SCADA/IS Section and Water Distribution Teams made strides in 2020 towards documenting the condition of valves and exercising valves on the distribution system using a Collector App (see page 52 for more information.) This is an important step towards stewardship and reducing non-revenue water.

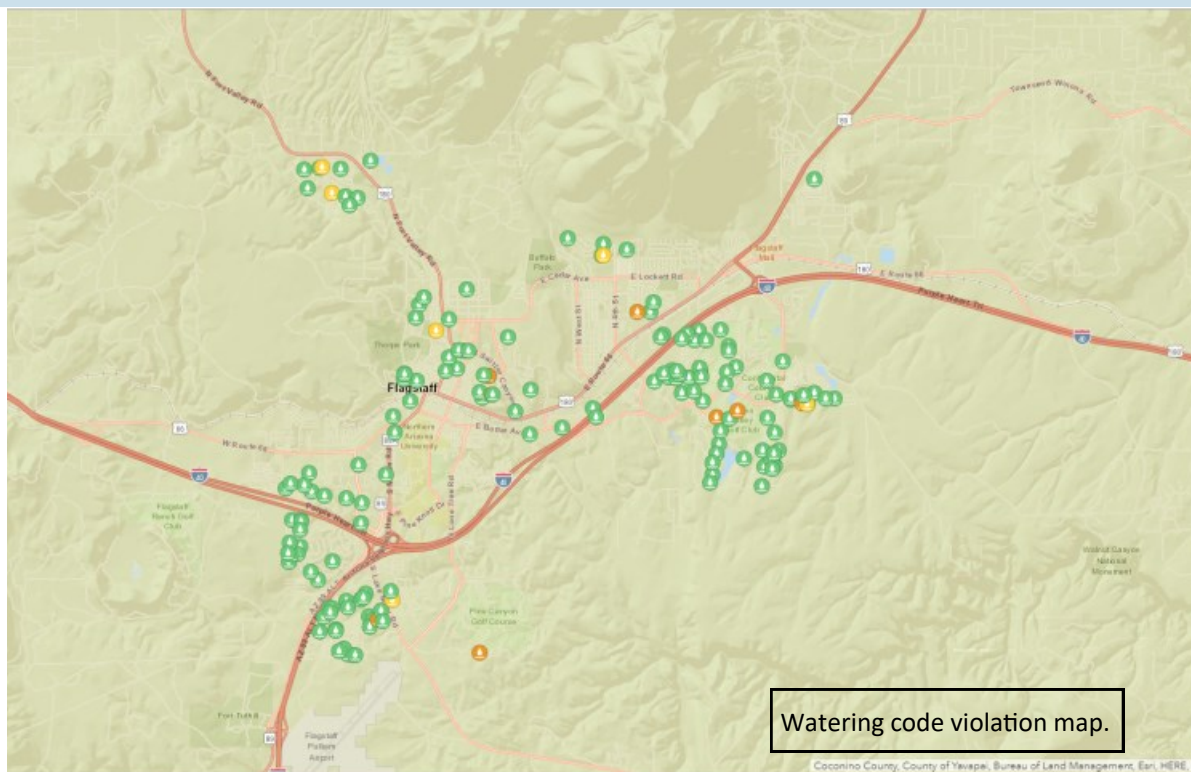
10-3 Water Conservation Program History & Customer Use Trends

Since 1989, Flagstaff has seen a drop in total per capita water use by 52% (below). During this same time, population has almost doubled while annual water used is less than what it was in 1990 (below). Below is a summary bullet list of what's contributed to an estimated saving of **95,800 AF of water in 25 years**:

- 1988 City Council adopted a Water Conservation Ordinance that included an odd/even watering day schedule & Water Availability Strategies (on page 51), developed in order to reduce peak summer demand
- 1990 Council adopted tiered residential rates (0-12K and >12K gallons) and created customer classes
- 1991 inception of Low Flow Toilet Rebate Program
- 1993 Rate increase adopted
- 1994 Rio Reclamation Plant online & reclaimed waterline constructed to serve summer irrigation
- Sometime between 1994 & 2003 tiered residential rate structure changed to 0-5K, 5-15K & >15K gallons & rate increase
- 2002 First and only time in history of the ordinance (see page 51) the Water Availability Strategy was elevated above Level I, Water Awareness. Level II went into effect May 10, 2002, Level III was in effect from June 21-Sept. 23, 2002. Ordinance was modified from 4 to 3 levels in May, 2003.
- 2003 Water Conservation Program established with program manager & 2 temporary enforcement staff
- 2005 Rebate program expansion to include turf removal & xeriscape, high-efficiency clothes washers, hot water re-circulators, pre-rinse spray nozzle installations, waterless urinal installations
- 2006 Tiered residential rate structure changed to 0-5K, 5-15K, 15-25K and >25K with rates increase
- 2009 & 2010 Water Conservation Program was cut from budget; from \$191,500 to \$21,000
- 2011 Tiered residential rate structure changed to 0-3.7K, 3.7-6.4K, 6.4-11.7K, >11.7K gallons
- 2011 Rebates for toilets, turf to xeriscape and rain water tanks funded since program was cut
- 2014 Two temporary enforcement staff added into the budget
- 2016 Program funding increased and added a full-time Water Conservation Specialist
- 2016 Water rate increase adopted
- 2017 Budget increase; new Low-Water Landscape Rebate Program; Water-Wise Business Program; Container to Rainwater Reuse Program
- 2018 Begin Water Conservation Strategic Plan; new Commercial Rebate Program
- 2018 Water Distribution began installing new smart water meters
- 2019 Water Conservation offered a refresh opportunity for Water Conservation Program Manager.
- 2020 Water Conservation Strategic and Implementation Plans adopted by Council (Dec. 2020)



10-4 Water Conservation Code Enforcement—2020



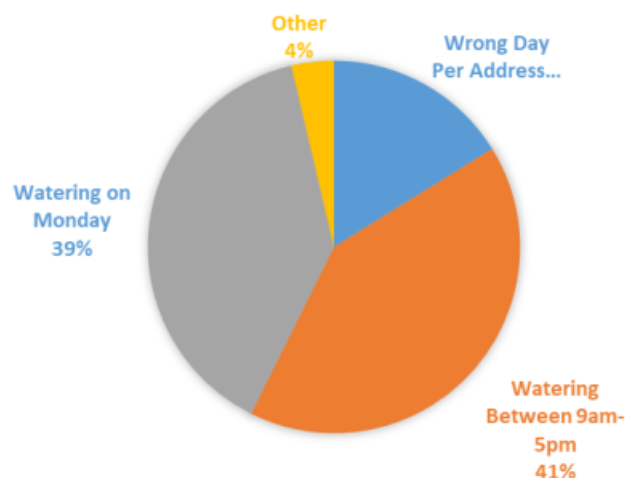
ENFORCEMENT SUMMARY: Due to the Covid-19 pandemic and subsequent Recession Plan, no Water Conservation Aides were hired to perform enforcement of the watering code during the summer of 2020. To help fill the gap, Pete Morrow, Water Resources Technician, and Kate Miele, Water Conservation Specialist assisted in enforcing the code.

Approximately 250 hours were dedicated to enforcement during the summer of 2020. In comparison, around 800 hours are spent during a normal summer when two staff are providing enforcement.

169 total violations were recorded for the summer of 2020, and no fines were administered. In comparison, 391 violations were recorded during the summer of 2018 when the team was fully staffed. However, summer 2019 was comparable with summer 2020 with 163 violations. This may be due to the fact that Water Conservation Aides were assisting with job duties that are normally under the purview of the Water Conservation Specialist during summer 2019 when that position was vacant.

Watering Violations by Type, 2020:

The chart to the right shows the breakdown of violations by type, showing that the majority of issues were watering on Mondays or during the wrong time rather than on the wrong day per address. 31 interactions that were recorded as general outreach or as neighbor complaints were not included in this chart.



10-5 Drought Preparedness—Water Availability Strategies

STRATEGY I

Water Awareness: In effect when water demand is equal to or less than safe production capability.

1. Implements Odd / Even Watering Schedule; Odd addresses are allowed to water T, Th, and Sa, even addresses on W, F, Su. No watering Mondays. Watering by hand allowed any day of the week. No watering between 9am and 5pm.
2. Prohibits unauthorized use of fire hydrants
3. Prohibits wasting water
4. Prohibits golf courses from irrigating with potable water
5. Provides for New Landscape Permits

STRATEGY II

Water Emergency: In effect when water demand exceeds safe production capability for five (5) consecutive days.

1. Continue rules established by Strategy I
2. New Landscape Permits not issued
3. Adds vehicle washing to watering schedule (exception for commercial car washes)
4. Prohibits washing buildings and paved areas
5. Prohibits filling fountains, ponds, pools with potable water
6. Prohibits use of potable water for construction activity
7. Implements Drought Rate Structure
 - Single Family Residential: Water Consumption between 6,401 and 11,700 gallons billed at 150% the established rate. Water Consumption in excess of 11,700 gallons billed at 200% the established rate.
 - Multi-Family, Commercial, Industrial, and Institutional: Billed at 120% the established rate.
 - Standpipes: Billed at 130% the established rate. Use limited to 25 mile radius.

STRATEGY III

Water Crisis: In effect when water demand exceeds total production capability, and the amount of water in storage may impair fire protection for the City.

1. Continue rules established by Strategy I and Strategy II
2. Prohibits all outdoor water use
3. Authorizes additional measure as deemed necessary

Safe Production Capability: 90% of total water resources available measured in million gallons per day, based on potable water production and distribution components.

11

WATER STORAGE & DISTRIBUTION

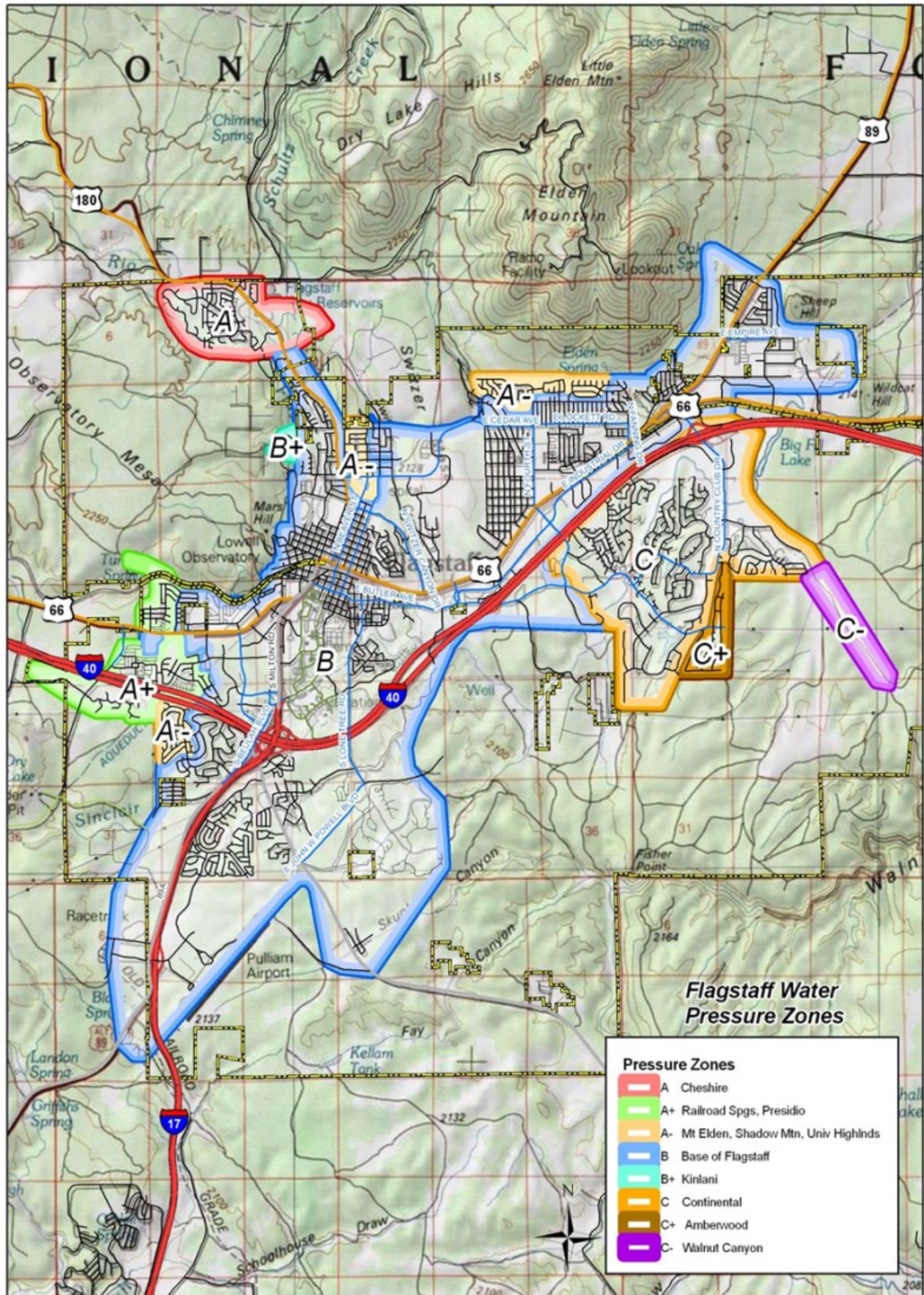
11-1 Water Storage Reservoirs

Name	Type	Dimensions	Tank Capacity	Floor Elv	HWL	Range
Main	circular, concrete	260d x 30h	12 MG	7106.00	7136.14	30.14
Christmas Tree	circular, concrete	210d x 20h	5.0 MG	7120.33	7139.11	18.78
Airport	circular, steel	48d x 24h	300 KG	6989.00	7012.17	23.17
Railroad Springs	circular, steel	86d x 24h	1.0 MG	7301.00	7324.00	23.00
Railroad Springs #2	circular, steel	86d x 24h	1.0 MG	7301.00	7324.00	23.00
Cheshire	circular, steel	90d x 24h	1.3 MG	7235.00	7260.00	25.00
Paradise	circular, concrete	132dx 25h	2.5 MG	7235.75	7260.33	24.58
Kinlani	circular, steel	34d x 24h	156 KG	7220.00	7243.00	23.00
Other Storage						
University Highlands	circular, steel	60d x 24h	500 KG	7057.50	7081.10	23.60
Raw Water Pump Station	square, concrete	35w x 18h	140 KG	6791.83	6806.00	14.17
LMWTP Clearwell	circular, concrete	130d x 16h	1.2 MG	6952.00	6967.00	15.00
LMWTP Backwash Tank	sphere, steel	36d x 30h	200 KG	7000.50	7030.50	30.00
LMWTP Filter Wetwell	rectangle, concrete	17w x 24L x 9h	32 KG	6952.45	6964.93	12.48
Woody Mtn. Clarifier	circular, concrete	70d x 16h	304KG	7173.25	7192.00	18.75
Woody Mtn. Forbay	circular, steel	21d x 24h	60 KG	7165.00	7189.50	24.50
Reservoir Filtration Plant, Clearwell	rectangle, concrete	47w x 70L x 10h	240 KG	7103.50	7115.67	12.17
Sinagua/Foxglenn	circular, steel	25w x 10h	33 KG	6804.00	6993.00	7.00
Ft. Tuthill	circular, steel	25	33 KG	6984.00	6993.00	7.00
Shop Well	rectangle, concrete	12w x 27L x 8h	19.5 KG	6791.00	6799.25	8.25
Interchange Well	rectangle, concrete	12w x 27L x 8h	19.5 KG	6784.66	6793.00	8.34
Rio Well	rectangle, concrete	12w x 27L x 8h	19.5 KG	6852.17	6860.50	8.33



The Woody Mountain Clarifier after renovations in December, 2020.

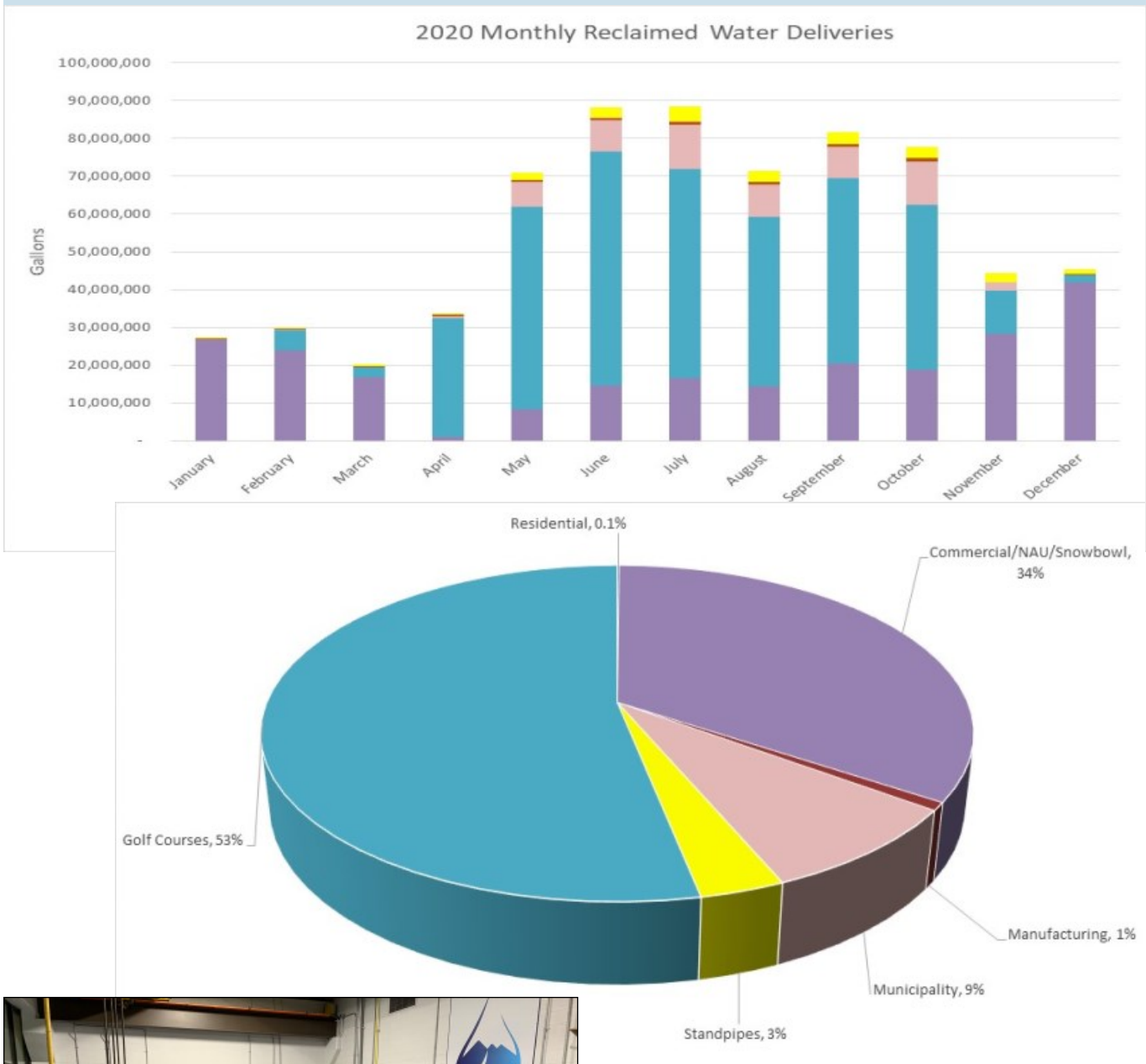
11-2 Flagstaff Water Pressure Zones



12

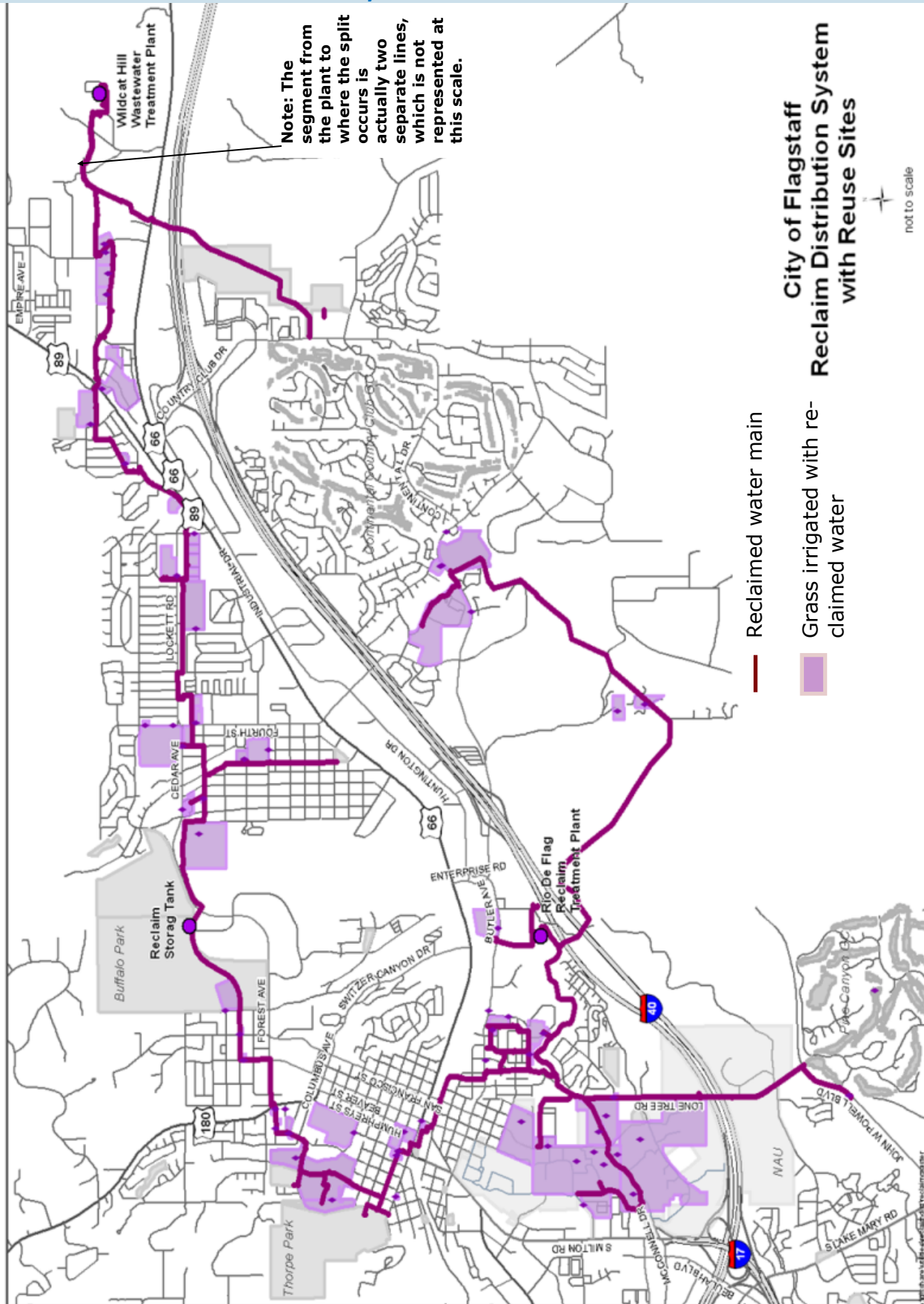
RECLAIMED WATER

12-1 Reclaimed Water Used by Customer Class



A look inside the pump room at Rio de Flag Water Reclamation Plant. Photo by Brad Hill

12-2 Reclaimed Water Distribution System



12-3 2020 Water Reclamation Plant Flow Report

WILDCAT PLANT	PLANT	TOTAL OF ALL	PLANT	RECLAIM DELIVERED	RECLAIM DELIVERED
	INFLUENT	TREATED EFFLUENT	DISCHARGE	REUSE SYSTEM	CONTINENTAL
MONTH	FLOW (GAL)	(GAL)	RIO DE FLAG (GAL)	FLOW (GAL)	FLOW (GAL)
JAN	102,796,000	96,691,000	96,682,000	0	9,000
FEB	98,406,000	92,603,000	87,076,000	0	5,527,000
MAR	127,100,000	128,051,000	125,606,000	75,000	2,370,000
APR	85,980,000	83,524,000	59,955,000	358,000	23,211,000
MAY	89,105,000	86,287,000	32,863,000	15,380,000	38,044,000
JUNE	93,591,000	91,610,000	22,433,000	28,636,000	40,541,000
JULY	95,767,000	93,929,000	36,740,000	17,676,000	39,513,000
AUG	103,208,000	102,114,000	58,567,000	13,999,000	29,548,000
SEPT	102,764,000	100,590,000	54,190,000	12,261,000	34,139,000
OCT.	106,585,000	102,223,000	67,021,000	4,445,000	30,757,000
NOV.	99,843,000	94,873,000	70,953,000	14,427,000	9,493,000
DEC	98,633,000	90,765,000	73,514,000	17,146,000	105,000
	1B	2B = 3B+4B+4B1	3B	4B	4B1
WCH TOTAL	1,203,778,000	1,163,260,000	785,600,000	124,403,000	253,257,000

RIO PLANT	PLANT	TOTAL OF ALL	PLANT	RECLAIM DELIVERED
	INFLUENT	TREATED EFFLUENT	DISCHARGE	REUSE SYSTEM
MONTH	FLOW (GAL)	(GAL)	RIO DE FLAG (GAL)	FLOW (GAL)
JAN	55,711,000	47,704,000	21,952,000	25,752,000
FEB	52,609,000	51,594,000	30,629,000	20,965,000
MAR	59,731,000	59,649,000	42,661,000	16,988,000
APR	53,832,000	50,862,000	31,532,000	19,330,000
MAY	53,217,000	49,930,000	16,352,000	33,578,000
JUNE	46,433,000	43,672,000	6,734,000	36,938,000
JULY	55,528,000	52,665,000	15,282,000	37,383,000
AUG	56,058,000	54,516,000	20,471,000	34,045,000
SEPT	54,090,000	52,849,000	17,929,000	34,920,000
OCT.	55,838,000	54,028,000	23,267,000	30,761,000
NOV.	54,134,000	47,618,000	20,568,000	27,050,000
DEC	50,469,000	48,659,000	21,546,000	27,113,000
	1A	2A = 3A+4A	3A	4A
RIO TOTAL	647,650,000	613,746,000	268,923,000	344,823,000
	1 = 1A + 1B	2 = 2A + 2B	3 = 3A + 3B	4 = 4A + 4B + 4B1
TOTAL (2) PLANTS	1,851,428,000	1,777,006,000	1,054,523,000	722,483,000
Acre-Feet	5,682	5,453	3,236	2,217

Notes: Total Reuse Delivered (2,217 AF) does not match Utility billing data of total "billed" (2,085 AF)

Wildcat no longer has site specific load out stations for city or county haulers. All reclaim users, except Continental, get water from the reclaim distribution system.

Total Processed/Unmetered = 1 - 2 = 1,851,428,000 - 1,777,006,000 = 74,422,000 gallons

a) Rio Plant Sludge/Septage - Not metered on main influent flow meter and self reported by haulers. Calculated at Wildcat.

b) Septage/Grease/Mud Sump - Grease received does not enter the wastewater treatment process. Mud is deposited into a drying bed and allowed to settle out, then any water is drained off into the treatment process.

c) Wildcat Unmetered - During the winter WC decants the water off the top of the Solids Stabilization Basins/SSBs and return it to the treatment plant to maintain acceptable levels in the SSBs. That could account for some 10 to 15 MGY unmetered. Unmetered stormwater also enters the SSBs, the 60 acre sludge injection field, and some smaller areas around the plant.

d) Wildcat flow meter(s) - In 2017, the Continental flow meter failed and flows were estimated for about one month. Starting in 2018, flow meters will be calibrated on an annual basis. A discrepancy in flow totals may occur after the meters are calibrated.

13

SCADA INFORMATION SYSTEMS

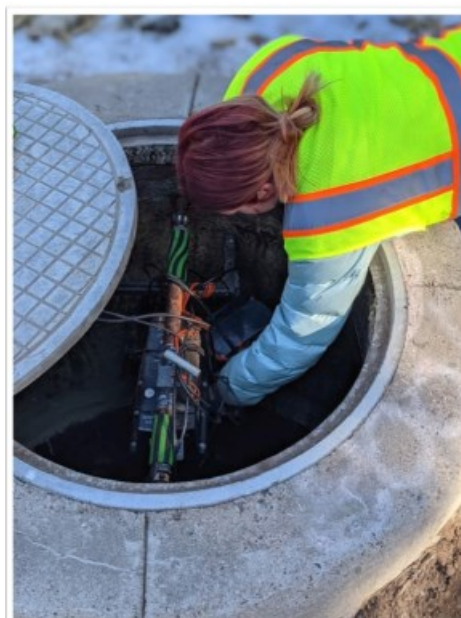
SCADA/IS (System Control and Data Acquisition/ Water Information Systems) formed a new section of Water Services in 2019. This Section manages a huge volume of complex data projects throughout the Division. Examples of data management include: the work order management system, GIS, meter data, field sensors, security systems, and the SCADA system. SCADA drives the remote-control processes of water production, field distribution and wastewater treatment plant operations.

A 2014 SCADA Masterplan demonstrated that Water Services needed improvements to our SCADA system, recommending additional funding dedicated to SCADA projects and a position to manage them. A SCADA Administrator position was created in 2017, reclassified to capture Information System (IS) in 2019 when the SCADA/IS section was created. This Section manages and oversees all data projects in Water Services, including SCADA. The two Instrumentation and Electrical (I&E) Supervisors require very specialized skills, moving from other sections where they continue to manage every aspect of water as it moves through the system; from well drilling and production to releasing A+ reclaimed water. Maintaining, upgrading and growing these data-driven systems has challenged the Team, stretching resources and staff while building needed skills and leveraging both internal and external expertise.

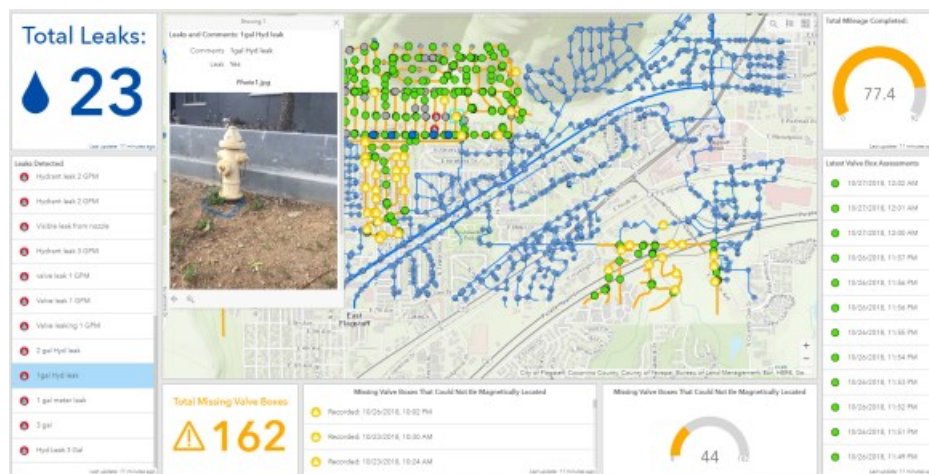
The Information System (IS) Administrator develops and maintains work order management system, sewer inspection van, and web applications, creating dashboards that display and collect new data in real time, such as the leak detection dashboard.

SCADA/IS Section pursues three standards:

- 1) Resilience:** Ensure continuity of operations for the entire system, including preparedness for disasters and emergencies such as fire, cyber-attack, or power outage. Maintain backup for all systems, ensure all service packs, updates, patches and firmware are up to date.
- 2) Serviceability:** Retain expertise and skillsets to effectively maintain our systems through ongoing training and contracts with vendors. Every part of SCADA and IS systems need qualified personnel that can track and perform maintenance.
- 3) Data-driven:** Provide Sections the best available data to allow informed decision-making by Managers, Directors and other City leadership.



Corryn Smith configures IIOT device to track water flows and levels.



Left: One of the Collector App Dash Boards

13-1 SCADA Information Systems—2020 Achievements

The focus in 2020 was to improve process monitoring and the asset maintenance system throughout the water systems. SCADA IS follows Strategic Objective Number 1, to create a standards-driven culture, collecting data and monitoring it throughout the system.

Work areas in 2020 included:

- Clarifier Upgrades. Both Primary and Secondary Clarifiers at the Rio WRP Plant received significant upgrades. We started by adding separate logic controllers for each system, providing alarms at the individual process level, thereby separating out the “single points of failure”. This isolates only the process affected by the alarm, leaving the rest of the system operable.
- Woody Mountain Booster Station also received separate logic controllers, and multiple single point-of-failure alarms. We also upgraded legacy hardware to a serviceable system. We also:
- Modernized PLC (program logic controller), Radio- Communication, HMI
 - Added monitoring UPS (uninterrupted power supply) power at site.
 - We are moving closer to establishing system-wide programing and equipment standards.
- Using an object-oriented programming model, we can create a library of standardized code consistent throughout the wastewater, water and reclaimed system. For example, all valves will be programmed with the same code, and all contractors will use our code library when working on our equipment. This add consistency to data-reading, streamlining trouble- shooting efforts. This culture of standards will make the system more efficient and easier to read, when all of the equipment is speaking the same language.
- Valve inspection program. IS Information Systems created a dashboard and collector app to enter valve data into the asset management system, or Cityworks. Assets can be added, deleted and conditional assessments updated with photos and GIS locations. The IS crew also built a Cityworks template to collect information about the valves, generating notifications for periodic inspections. The dashboard allows field crew to view and update information on the valve’s condition. If an inspected valve is below specified condition score triggers, a work order is automatically generated. By writing our own programs and requiring In-house and outside contractors use the same programs, we can standardize and streamline the inspection process, using the Cityworks workorder and inspection management system. This is the first valve inspection program implemented by Water Services
- Stormwater Programs. An inventory was created in GIS, providing a dashboard for asset management. An inspection schedule and workorder program was developed in Cityworks to log and track maintenance on the City’s Stormwater Open Channel Infrastructure. Conditional assessment is logged for inventory items to track inspections, creating work orders when poor assessments trigger maintenance needs.
- Continued work on the key-scan servers security systems.



Corryn Smith connects to the IIOT device in the manhole.

14

STORMWATER MANAGEMENT

The City's Stormwater Management program includes projects and programs that address stormwater quantity (flood control), stormwater quality (AZPDES Municipal Permit), FEMA floodplain administration and watershed management and restoration.

The Stormwater Section is funded by the stormwater utility that was established in 2003. The Utility currently provides for a Capital Improvement Program (CIP), stormwater infrastructure maintenance, development permit review, drainage investigations and floodplain administration.



14-1 Key Program Summary (descriptions are provided on subsequent pages)



1. Capital Improvement Program
2. Construction Site Inspections
3. Drainage Investigation Response
4. Development Review
5. Floodplain Administration
6. Open Channel Maintenance
7. Watershed Planning & Museum Fire Response

14-2 Capital Improvements Program (CIP)

City Stormwater staff members are responsible for managing Stormwater's Capital Improvements Program, which is funded at \$700,000 per year. Capital Improvement projects include the Army Corp of Engineers Rio de Flag Flood Control design review, Wildwood Hills detention-retention pond, Phoenix Avenue Bridge replacement design, Steve's Wash crossing at Soliere, Columbia Circle drainage improvement, and Spruce Wash at Dortha Inlet improvement. Staff also met with the Flagstaff Unified School District and Maricopa County Flood Control District to begin discussions for a regional detention basin at Killip Elementary School. The Stormwater Section also solicited bids from the City's Horizontal JOC contractors to begin a series of Spot Improvement bundled packets to fix local drainage problems in primarily residential neighborhoods.

14-3 Construction Site Inspections

The Stormwater Section is tasked with conducting inspections of commercial and multi-unit residential projects approved within the City. These inspections are intended to ensure compliance with stormwater development requirements and to provide direction on appropriate Best Management Practices (BMPs) installation and maintenance in accordance with the Stormwater Pollution Prevention Plan (SWPPP) or Erosion Control Plan (ECP). In 2020, the Stormwater Inspector visited 74 individual sites with a total of 1,210 individual inspections.

MS4 Program

The City of Flagstaff's Municipal Separate Storm Sewer System (MS4) program was audited by ADEQ and received top marks regarding best management practice (BMP) inspection for erosion and sediment control, post-construction BMPs, and drainage complaint response.

Rock and cinder track out pads prevent sedimentation to streets adjacent to the project location.



Properly installed silt fence prevents stockpiled sediment from migrating.



14-4 Drainage Investigation Response

The Stormwater Section conducted **20 drainage investigations** during the last year. These investigations include illicit discharge, floodplain, private and public flooding reports. These investigations can result in the identification of maintenance needs or projects that need to be addressed through the City's Water Services Department. During investigations on private property, staff provides guidance to home owners detailing how to improve drainage on their lots.



BEFORE: Inspector responds to drainage complaint.



AFTER: Inspector locates and clears blocked inlet.

14-5 Development Review

The rate of development in Flagstaff continued at a fast pace in 2020. The Stormwater Section participates in the City Interdivision Staff (IDS) process. This process provides review for all Concept and Site Plans submitted to the City. The Stormwater Section reviewed 67 new Site Plans this year. Each site plan goes through a multiple review process that starts with Concept Plan and end with an approved Site Plan. This IDS process also reviews all plats, both preliminary and final, zoning amendments, both concept and direct to ordinance in conjunction with a site plan, and annexations. The Stormwater Section also reviews all Civil Plan submittals both for City Capital projects as well as private development Civil Plans and outside agency Civil Plans that are within City Floodplain areas. This review process requires a detailed review of all civil construction drawings and submitted engineering drainage reports for compliance with City Code. This Stormwater Section also reviews all building permits submitted to the City.

2020 Permit and Plan Review	2019	2020
Pre-application meetings	79	64
New Concept Plans (not including resubmittals)	67	54
New Site Plans	27	18
Total first review Concept and Site Plans	94	72
Engineering Plan Review (not including resubmittals)	56	38
Building Permit Submittals (not including resubmittals)	987	858
Grading Permits	28	21
New zoning map amendment review submittals	4	7
New final Plat Submitted in 2020	14	6
New Annexation Submittal	1	0
Temporary Use Permit Reviews	43	39
Floodplain use permits review	20	11

14-6 Floodplain Administration

The Stormwater Section continues to support the Flagstaff Engineering Capital Improvement Section in the joint City of Flagstaff-Army Corp of Engineers Rio de Flag Flood Control Project. Stormwater staff reviews technical, stormwater aspects of the project that this section will manage upon completion. Water Services has taken over the outreach portion of this project, assisting in distributing information developed by the marketing consultant.



Spruce Wash vegetation maintenance between July (left) and August (right) 2019, the asterisk indicates the same tree.

The Stormwater Section is tasked with the administration of the FEMA floodplains throughout town. We participate in the National Flood Insurance Program (NFIP), which reduces flood insurance premiums by 25% for our residents through the Section administration of the Community Rating System (CRS). Flagstaff is currently a Class 5 community, one of the highest ranked CRS communities in Arizona. The Stormwater Section also administers the Floodplain Regulations adopted by City Council. Stormwater provides assistance to citizens considering development in the floodplain by conducting Flood Zone Determinations. These determinations provide specific information in writing to the customer allowing them to better understand any restrictions on projects proposed in the floodplain. This past year the Section completed **18 flood zone determinations**. Stormwater also issues floodplain use permits for allowed activities within the floodplain. This requires review of submitted construction documents and reports to determine compliance with floodplain codes.

14-7 Open Channel Maintenance

The Stormwater Section maintains 28 miles of FEMA reported open channels and another 112 miles of natural channels and minor ditches within City limits. These stream reaches consist of City owned properties, public rights-of-way, public easements, and private drainage easements. Maintenance projects are listed on the City's website as well as through annual reports. Annual assessments include 164 individual stream reaches compiled in CityWorks, the Water Services CMMS software. The annual report is here: [Flagstaff.az.gov/DocumentCenter/View/65777/2020-calendar-year-maintenance-summary](https://flagstaff.az.gov/DocumentCenter/View/65777/2020-calendar-year-maintenance-summary)

Maintenance in 2020 included:

- Dredging of Clay Wash between Blackbird Roost and Malpais Lane
- Stream clean-ups downstream of the Museum Fire burn area
- Dredging of Spruce Wash at Cedar Avenue
- Vegetation removal along the Rio de Flag in Cheshire and Coconino Estates
- Curb and gutter repair along Clay Wash inlets

Spruce Wash illegal fill removal and channel improvements. Summer 2020:

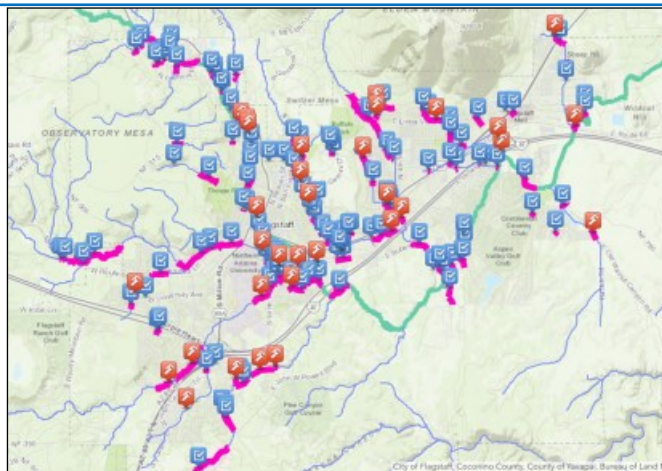
Before



During



Culvert cleaning using the new Stormwater combo truck (left). Closed work orders and inspections for open channel maintenance (right).



14-8 Watershed Planning and Museum Fire Response

The Stormwater Section assists with watershed planning and management in the City and at areas used by Water Services. Activities included being a core member of the Watershed Alliance for the Rio de Flag (WARF), assisting with the Southside Community Specific Plan, assisting Water Resources with Upper Lake Mary Watershed monitoring, collecting rain, stream, and sediment data in select washes, and assisting with the Museum Fire emergency operations and post-fire flood response.

The Stormwater Section was able to install 11 new flood ALERT gauges in 2020 with partial funding from the Department of Emergency and Military Affairs (DEMA). The gauges allow for real-time monitoring of flow and precipitation in nearly all of the FEMA regulated floodways within the city. Continued monitoring of the Museum Fire burn area was also conducted with cooperation with the Coconino County Flood Control District, NAU, and Arizona Geological Survey. This year was the driest on record, there were no significant flow events during 2020 from the burn area or elsewhere in the city.



Area included in Stormwater Resiliency Project



Forest runoff across cross-vein weir
for channel protection

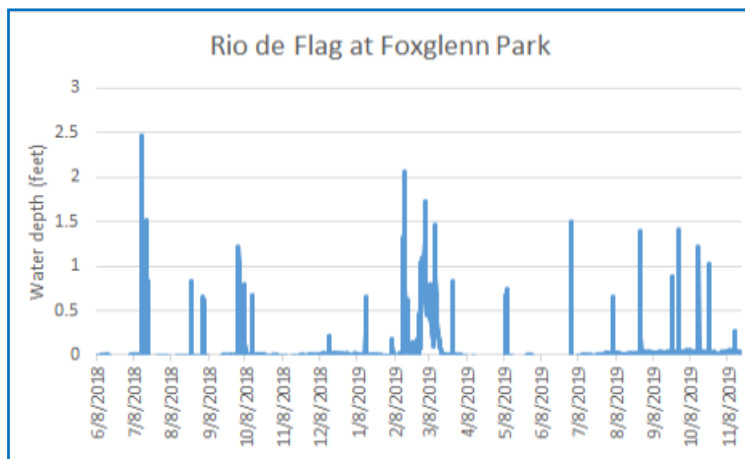
14-8 Watershed Planning and Museum Fire Response (continued)

Stormwater maintains a series of rain and stream gauges for public safety, drainage design, and hydrologic studies. The gauge network can be viewed in real time at: <https://rain.flagstaffaz.gov/jefmap/>

The rain and stream gauge network is currently operating under the ALERT 1 radio telemetry protocol. Gauges are maintained annually and data is summarized for long-term interpretation of rainfall-runoff. Improvements in data analysis this year included a full stage-discharge study for each site, geomorphic relationship between watershed size and stream capacity, and the continuation of a Rio de Flag hydrology study that began in 2018 with FEMA funding. Results will inform the next iteration of the City of Flagstaff Stormwater Design Manual.



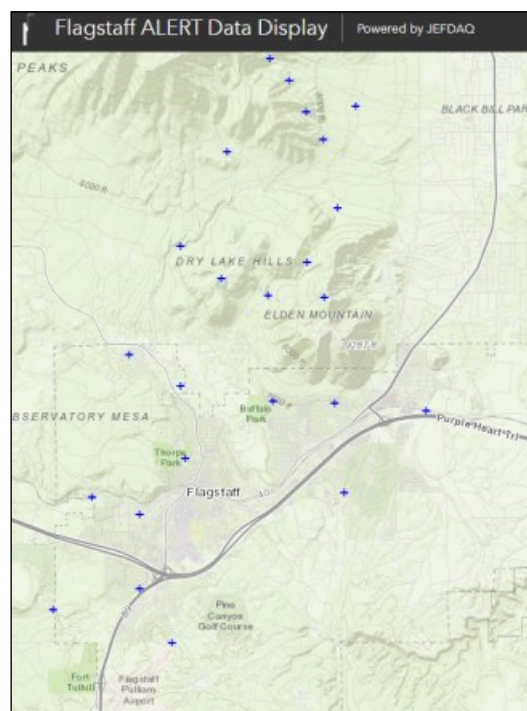
Gauge installation at the South Fork of Clay Wash.



A gauge data chart, depicting water depth in the Rio de Flag at Foxglenn Park.



Rain gauge located at Frances Short Pond.



Flagstaff vicinity flood alert network. Blue crosses indicate gauge locations.

15

REGULATORY COMPLIANCE

The mission of the Regulatory Compliance Section of the Water Services Division is to ensure that the City of Flagstaff is compliant with all sampling and reporting requirements and best management practices (BMPs) as directed under state and federal regulations and permits for our drinking water, wastewater, recycled water, surface water, stormwater, industrial pretreatment and backflow programs. The Regulatory Compliance Section is also responsible for ensuring each facility in Water Services is properly permitted and any discharge is correctly reported to the state Arizona Department of Environmental Quality. Staff philosophy is responsiveness, performing duties with honesty and integrity, and a commitment to meeting industry standards of excellence.

The section is committed to a goal of 100% customer satisfaction. This is achieved by dedication to exceeding customer expectations and by continuously improving our programs. We value co-worker input and strive to maintain high motivation by providing an environment that encourages improvement and teamwork.

Core functions of the Regulatory Compliance section include sampling, testing, documenting and reporting the quality of the City's water, wastewater, reclaimed water and industrial pretreatment and backflow systems as directed under state and federal regulations and permits. The Section manages two State licensed laboratories, administers the Multi-Sector General Permit (MSGP) at the Wildcat Hill and Rio de Flag Wastewater Reclamation Plants, administers the Municipal Separate Storm Sewer System (MS4) permit for the City and works with regulatory agencies to update permits. The section also coordinates the Water Services Division's safety programs. The core functions of the section include overseeing the following:

- Two State licensed laboratories at the Lake Mary Water Treatment Plant and the Wildcat Hill Water Reclamation Plant.

- Surface Water and Aquifer Protection Permits at both the Rio de Flag and Wildcat Hill Water Reclamation Plants.
- Air Quality reporting and registration for the Wildcat Hill Water Reclamation Plant
- City's Industrial Pretreatment Program.
- City's Fats, Oils and Grease (FOG) Program.
- City's Cross Connection Program.
- City's Municipal Separate Storm Sewer System (MS4) program.
- City Area Wide de Minimis permit for small discharges.

The City of Flagstaff currently has seven permitted industries under the Industrial Pretreatment Program. The largest industries include an ice cream cone manufacturer and a pet food manufacturer. The Section also administers the Multi-Sector General Permit (MSGP) at the Wildcat Hill and Rio de Flag Water Reclamation Plants and works with regulatory agencies to update permits.

The Regulatory Compliance Section represents the City by maintaining relationships with other professionals in the water and environmental compliance field and participating in or hosting meetings and workshops. The section is a liaison with numerous outside agencies and organizations that include the United States Environmental Protection Agency (USEPA), Arizona Department of Environmental Quality (ADEQ), Arizona Department of Water Resources (ADWR), and Environmental Laboratory Advisory Committee. In addition, staff review proposed water quality legislation and provide input to State Agencies, City Council and Legislators. Staff also provides water quality regulatory permit administration for all programs within the Regulatory Compliance Section for various Federal (USEPA) and State (ADEQ) programs including: Safe Drinking Water

Act, Clean Water Act, Clean Air Act, National Pollutant Discharge Elimination System (NPDES), Arizona Pollutant Discharge Elimination System (AZPDES), Arizona Aquifer Protection Permit (APP), Reclaimed Water Permit, Multi-Sector General Permit (MSGP), Municipal Separate Storm Sewer System (MS4), and Emergency Operations and Safety Programs as required.

The section authored and passed an Enforcement Response Plan for the Industrial Pretreatment, Stormwater and Cross-Connection programs through City Council in 2018. The ERP clearly outlines the enforcement processes that will be followed by staff in instances of non-compliance.

The Industrial Pretreatment program has been especially busy this last year with the following accomplishments:

- Conducted an updated Local Limit study; new limits adopted by Council in April, 2021
- Developed a Fats, Oils and Grease (FOG) Manual and made City code changes to administer the manual
- Council adopted City code changes to streamline and provide better efficiency to the Backflow and Cross-Connection Control program in April, 2021
- Developed separate informational brochures for the residential and commercial FOG program
- Successfully prepared the pretreatment program

for an ADEQ audit with no violations

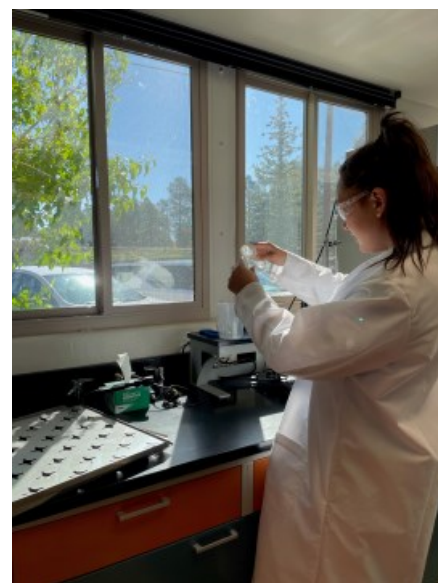
- Developed Cross-connection information brochure
- Developed informational cards to describe the SwiftComply compliance system to assure compliance with grease interceptor pumping and help eliminate sanitary sewer overflows
- Developed helpful informational placards for restaurant kitchens in both English and Spanish
- Streamlined the pretreatment inspection process with a pre-inspection and annual inspection checklist.
- Revamped the Pretreatment annual report that is sent to ADEQ to make it more understandable and streamlined.

The wastewater lab has been busy with the following:

- Successfully renewed the surface water permits for the Wildcat Hill and Rio de Flag plants
- Successfully renewed the reclaim water permit
- City code adopted changes to the scavenger waste or septage and grease program in April, 2021

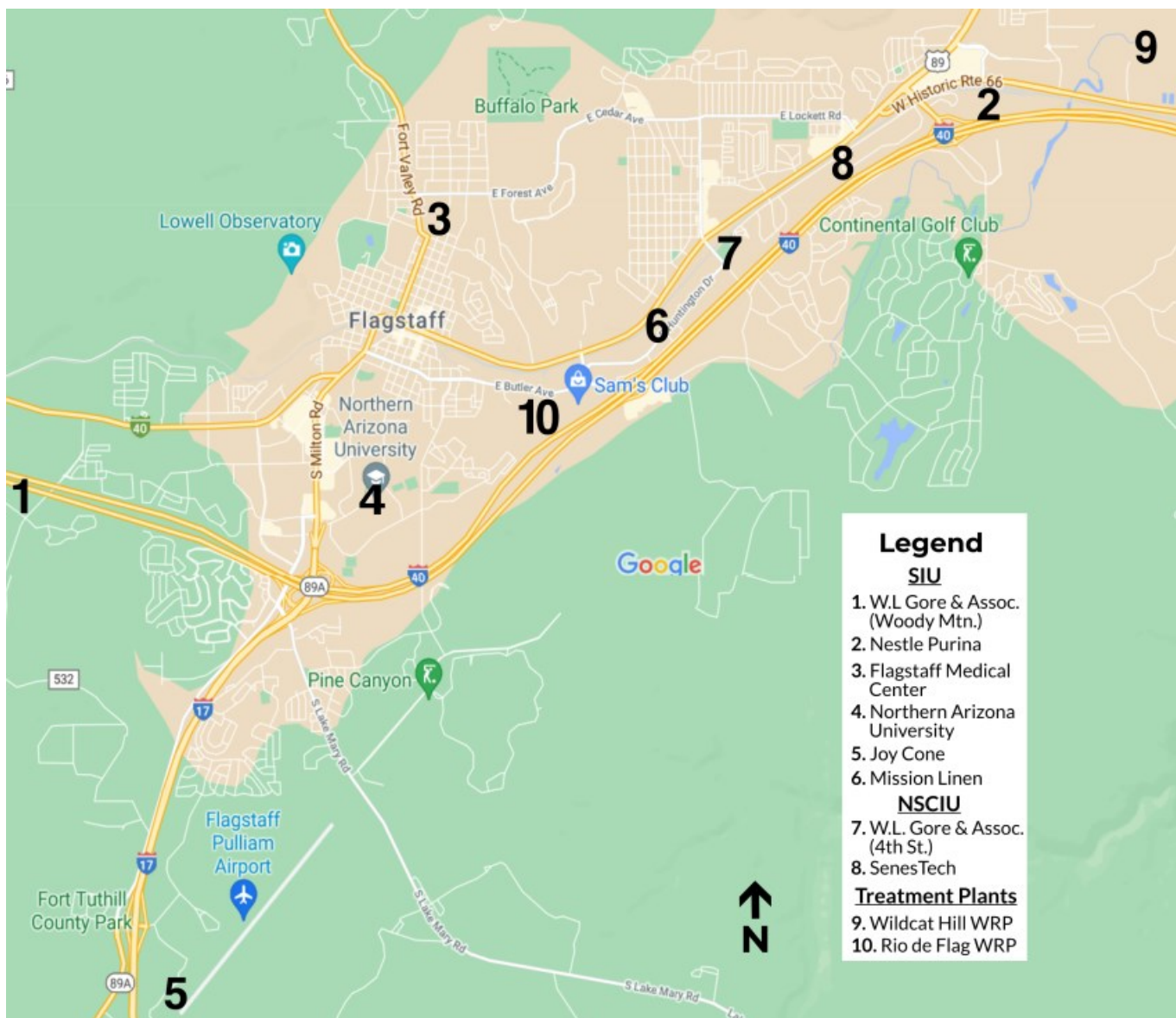
The drinking water lab has been busy with the following:

- Conducted the triennial lead and copper sampling event. All samples were below the alert level for copper and lead.
- Addressed 20 drinking water complaints
- Developed a Risk and Resilience assessment in-house to meet EPA requirements.



Janice Hakala tests water quality in the lab.

15-1 Industrial Waste Significant Industrial Users



Significant industrial user (SIU)
 Non-significant categorical industrial user (NSCIU)
 Water reclamation plant (WRP)

16

RED GAP RANCH

16-1 Red Gap Ranch Updates

Red Gap Ranch was identified and purchased as a future City water resource in 2005. The ranch includes 8,500 deed acres and 16,500 state-leased land. The ranch is not needed for at least 10 years (see page 15.)

Even though the timing is at least a decade out before needing a new water source, history is a good indication that water projects take decades of planning to realize. The City commissioned a pipeline feasibility study by Jacobs Engineering in June of 2008 to analyze alternative pipeline alignments to convey water from the ranch to the City. This feasibility study was delayed for many years due to right-of-way and access negotiations with the Arizona Department of Transportation. The feasibility study is currently in Phase 2, scheduled for completion in Fall 2021.

16-2 Red Gap Ranch Well Data

Local Name	Reg. Number	Surf. Elevation (feet amsl)	Most Recent Depth to Water (feet)	Most Recent Water Elevation (feet amsl)	Data ¹ Source	Date Measured	Well Depth (feet)	Diameter (inches)	Perf. Interval (feet)	Date Well Complete
Sunshine Well	601277	5230								
Outpost Well	597831	5330	573.52	4756	COF	4/2/2020	930	5	690-890	2003
Lake Tank Well	590957	4870	171.24	4699	H.S.I.	11/19/2002	570	6		2002
Twin Tanks Well	597832	4950	252.07	4698	COF	3/1/2019	880	5	660-860	2003
Red Sands Well	601276	4951	240.53	4710	H.S.I.	11/18/2002				
Stone-1	601273	5045								
Stone-2	601274	5065								
Stone-3	601275	5055	316.44	4739	H.S.I.	5/15/2003				
Stone-4	601272	5045								
Stone-5	809401	5055	342.4	4713	COF	9/13/2012				
Cedar Well	597833	5180	441.33	4739	COF	5/10/2019	910	5	590-690, 790-890	2003
Headquarters Well	601278	5030	131.48	4899	COF	5/10/2019				
RGR - Well-1	590153	4835					180	12	OPEN	Incomplete
RGR - Well -2	590823	4970	220	4750	COF	4/1/2015	695	12	380-460, 540-600, 640-660	2002
MW-2W	590821	4970	244.5	4726	COF	7/12/2020	500	5	380-480	2002
MW-2S ⁴	590822	4970	237	4733	COF	7/12/2020	500	5	380-480	2002
RGR - Well -3	590338	5030	278.5	4752	COF	5/11/2016	840	12	460-520, 660-720, 760-800	2002
RGR - Well -7 ²	601271	4832	168.07	4664	ADWR	2/20/2020	440	4.5	OPEN	Deepened in 2002
RGR SW Well 1 ³	912928	5037	287.88	4749	COF	4/16/2021	435	16	OPEN	2011
RGR SW Well 2	912929	4948	232.5	4716	COF	4/16/2021	420	16	OPEN	2011
RGR SW Well 3	912930	5173	420.3	4753	COF	4/16/2011	475	16	OPEN	2011
RGR SW Well 4	912931	5314	482.7	4831	COF	4/2/2011	640	16	OPEN	2011
RGR SW Well 5	912932	5314	541.3	4773	COF	4/2/2021	700	16	OPEN	2011
RGR SW Well 6	912933	5063	316.3	4747	COF	3/1/2019	445	16	OPEN	2011
RGR SW Well 7	913556	4995	N/A				38	24		Incomplete
RGR SW Well 8	913557	4996	N/A				38	24		Incomplete
RGR SW Well 9	913560	5012	N/A				38	24		Incomplete
RGR SW Well 10	913561	4964	N/A				38	24		Incomplete

1. COF = City of Flagstaff; H.S.I.=HydroSystems Inc

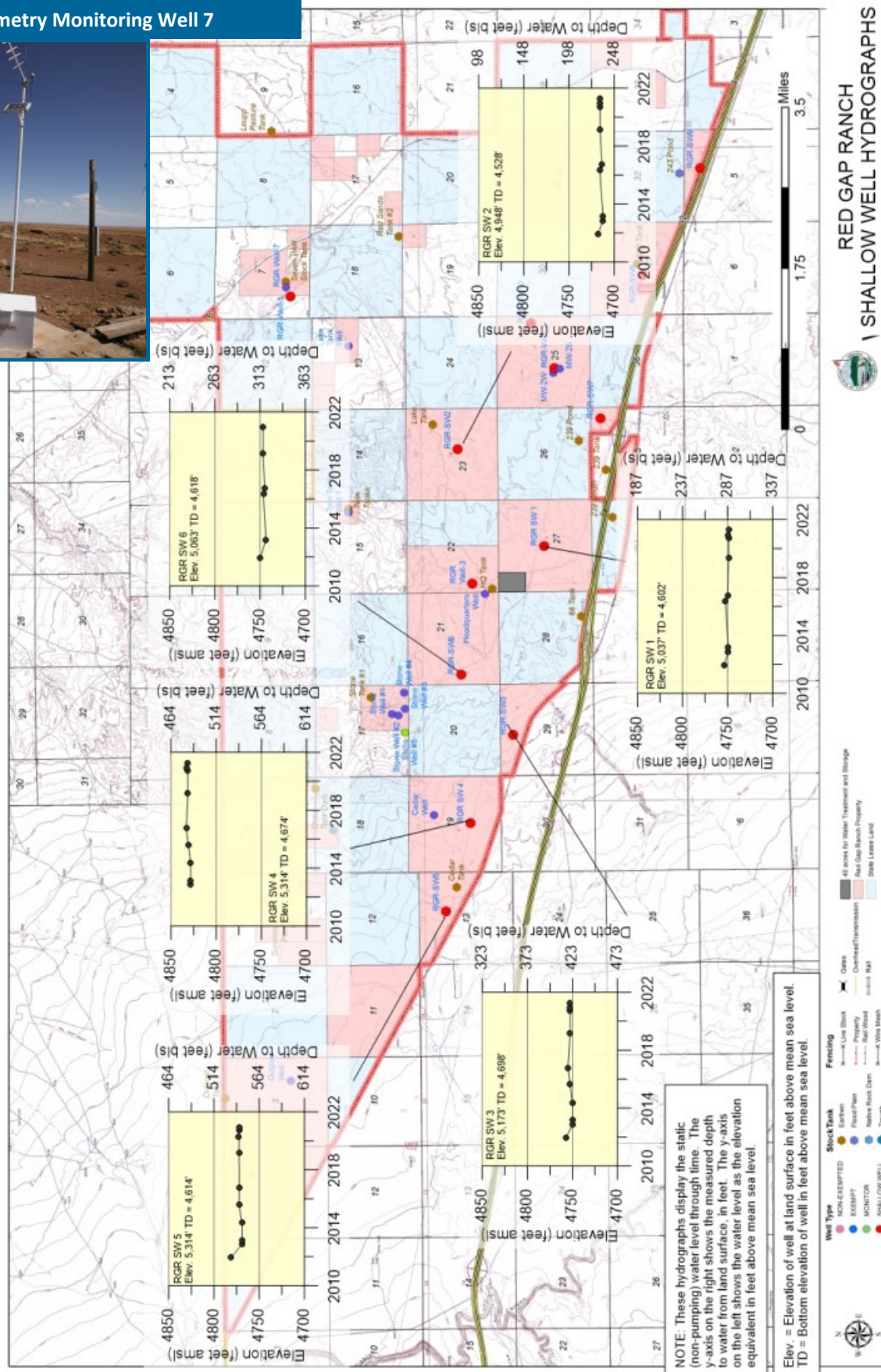
2. Pursuant to agreement with ADWR dated 2013, continuously monitoring water level

*AMSL = Above mean sea level

3. Red Gap Shallow Wells (SW)

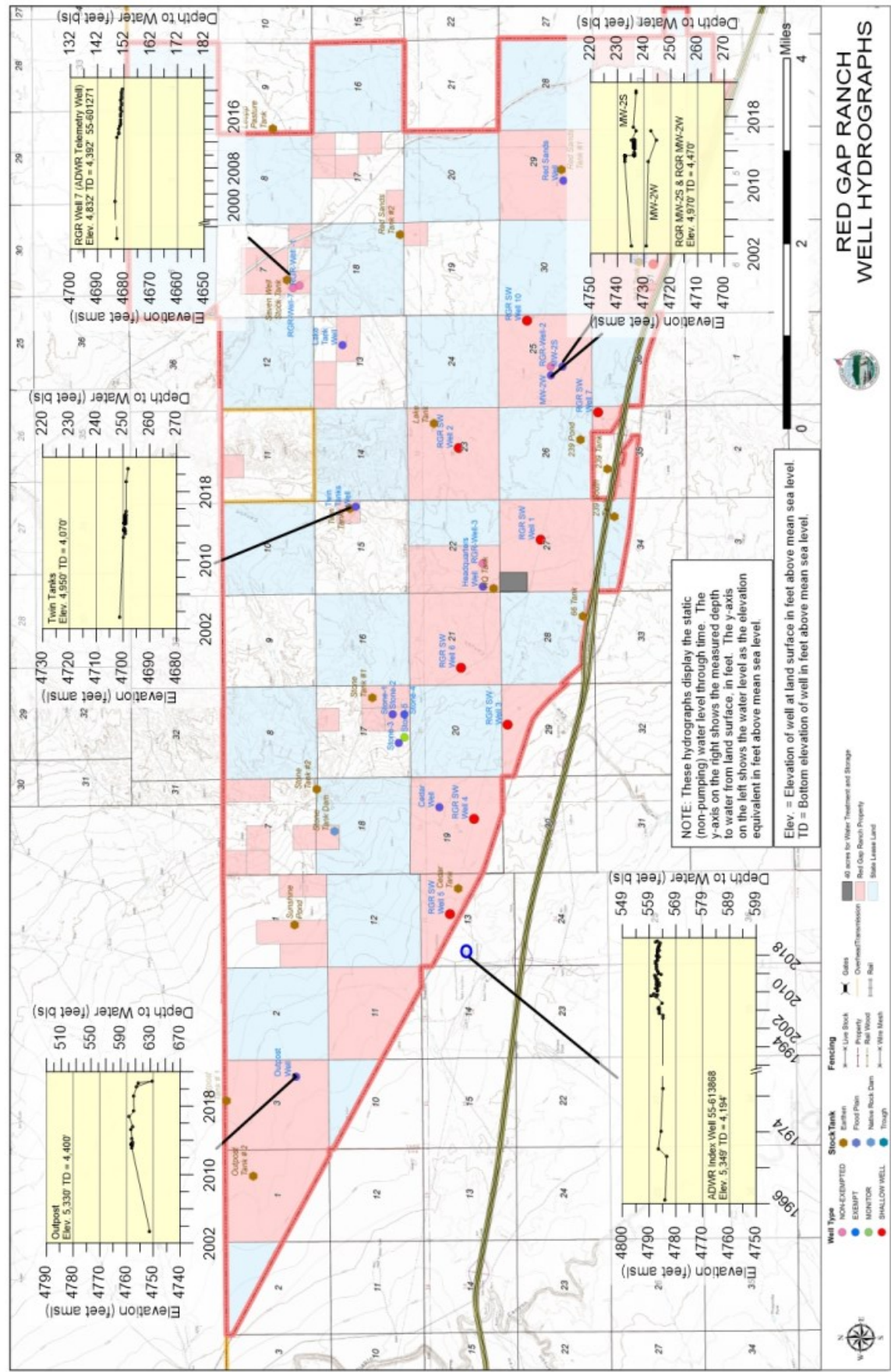
ADWR Groundwater Site Inventory (GWSI)

RGR Telemetry Monitoring Well 7



RED GAP RANCH
SHALLOW WELL HYDROGRAPHS

16-3 Red Gap Ranch Well Locations and Hydrographs, continued



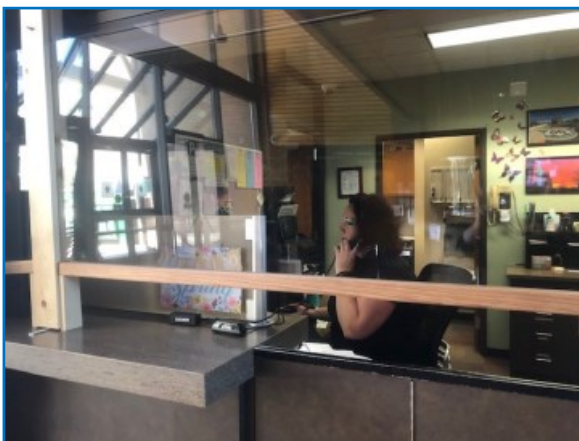
17

CUSTOMER SERVICE

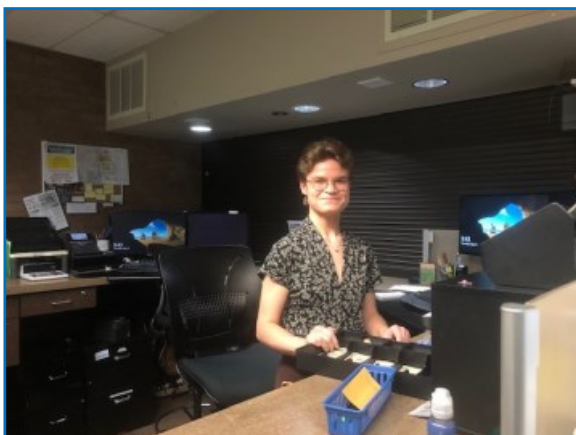
Customer Service is responsible for all billings, collection and service activity. They oversee the meter readings, accomplish service connections/terminations, track customer consumption and field service calls. Housed under Management Services, the customer service team works closely with Water Services staff to identify possible leaks, help customers monitor their usage and pay their bills. Customer Service manages the load out stations software and tracking, using a card key system. Customer Service provides the front-line customer experience, fielding billing and general water inquiries.

2020 Notable Accomplishments

- All services- payments, account activations/terminations were adjusted to remote operations.
- Customer service fielded over 25,000 inbound calls
- Completed nearly 3,000 new account activations, 2,500 billing edits, and 500 landlord service transfers.
- Meter services completed nearly 2,000 Electronic Radio Transmitter installs on newly installed meters. These allow for radio transmittal of meter data. Now less than 100 meters in the City are still read visually.
- Transitioned to new Field Collection System, allowing for increased data collection capability in the future. Customer service, Billing/Collection, and Meter Services team were recognized with City Manager Award for efforts in this transition, which took months of testing and fine tuning to ensure compatibility with the current billing system and accurate reporting of monthly meter data.
- With disconnects for non-payment being suspended, team implemented doorhanger reminder program. Over 250 doorhangers were dropped, with over \$125,000 in past due collected as a result.



Customer Service Representatives:
Celeste Coup (upper left), Krista Devlin
(below), and Rhiannon Thomas
(bottom left).



18

2020 MISCELLANEOUS INFORMATION

18-1 Statistics

psi	Pounds per square inch	2.304 feet of water head
Acre-foot	Gallons in 1 acre, 1 foot deep	325,851 gallons
Cubic foot	Gallons in 1 cubic foot	7.48 gallons
Cubic foot per second (cfs)		450 gallons per minute
Million gallons per day		694 gallons per minute
Break horse power		(total lift x gpm)/3960
		0.67 kwh (kilowatt hours)
GPCD	Gallons per capita per day	
mg/L	milligram per liter or part per million	
TTHM	Total Trihalomethanes	

CONVERSIONS

psi	Pounds per square inch	2.304 feet of water head
acre- foot	Gallons in acre, 1 foot deep	325,851 gallons
cubic foot	Gallons in 1 cubic foot	7.48 gallons
cubic foot per second (cfs)		450 gallons per minute
million gallons per day		694 gallons per minute
Break horse power		(total lift x gpm)/3960
		0.67 kw (kilowatt hours)
GPDC	Gallons per day per capita	
mg/l	Milligram per liter	part per million
TTHM	Total Trihalomethanes	

CITY PERMIT NUMBERS**WATER**

Water System No. 403008
Recycled Water Type 3 – R511384

WASTEWATER

Wildcat Hill WRP
Rio de Flag WRP

AZPDES AZ0020427
APP 100760
APP 102421
AZPDES AZ0023639

AWWA Membership No. 00033465
ADWR Designation No. 41-900002.0002
ADWR Community Water System ID: 91-000086.0000

REVENUES (FY= July thru June) Water, Sewer, Reclaimed Water and Stormwater Revenues.
FY 19 & 20 include capacity fees and interest.

WATER FY 2020	\$ 18,802,574	FY 2019	\$ 20,274,806
SEWER FY 2020	\$ 11,470,155	FY 2019	\$ 11,584,890
RECLAIM FY 2020	\$ 1,111,418	FY 2019	\$ 818,176
STORMWATER FY2020	\$ 4,226,663	FY 2019	\$ 3,971,808

SYSTEM INFORMATION 2020

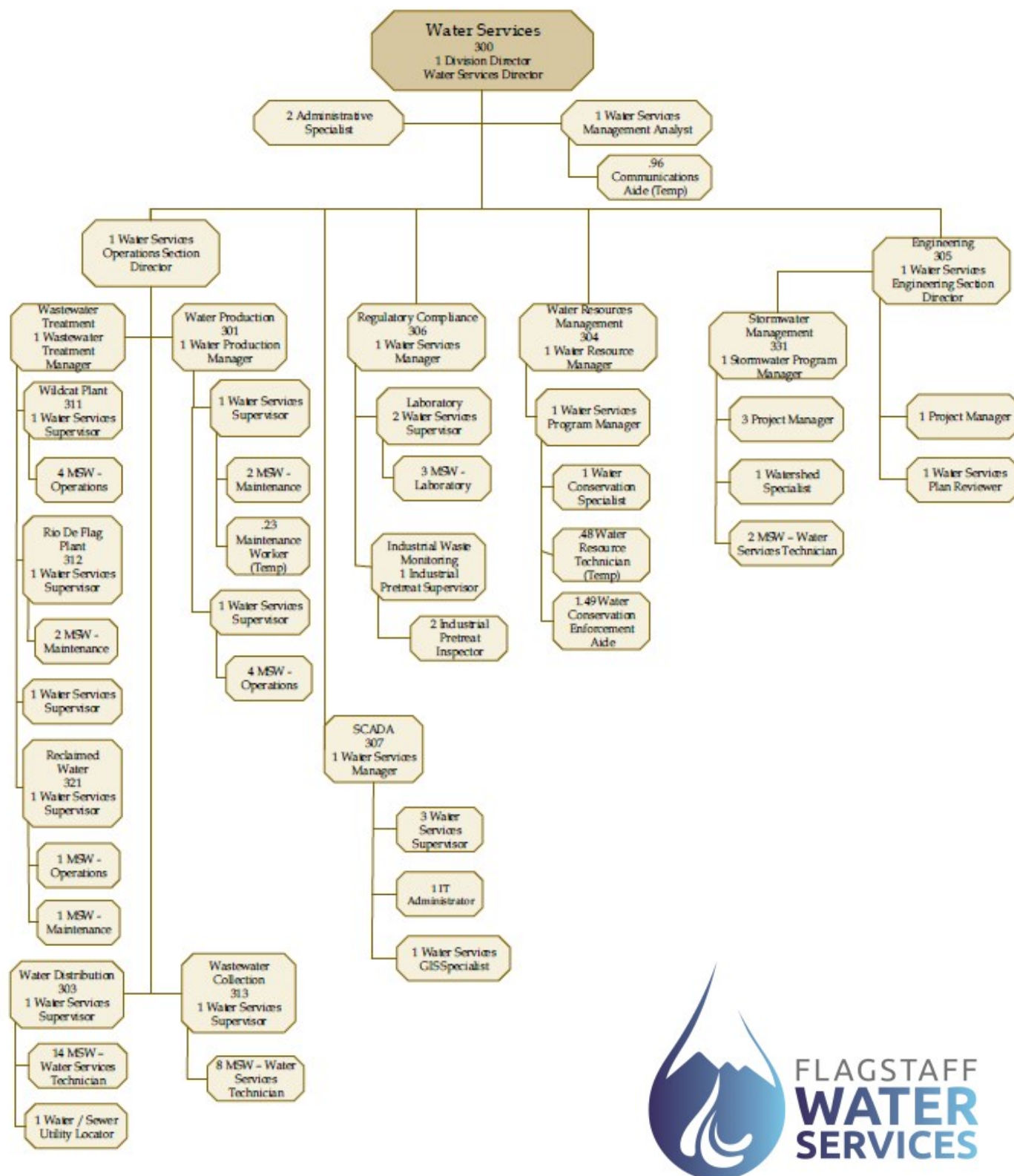
Number of fire hydrants – 3,397
Number of reclaim hydrants - 14
Number of manholes – 7,734
Number of valves – Reclaim = 250, Water control valves = 472, Water system valves = 11,473
Number of groundwater wells – 28
Miles of sanitary sewer – 281.811 (gravity), 4.347 (pressurized)
Miles of water main – 450.433 (pressurized), 1.01 (gravity)
Miles of reclaim pipeline – 25.83 active
Miles of storm drain – 68.077
Average annual gallons per household in 2020 – 156 gallons per house per day
Average annual gallons per capita per day in 2020 – 100 gallons per person per day (including Non-Revenue Water)
Upper Lake Mary capacity – 16,300 acre feet (USGS OFR 2008-1098)
Year 2020, number of housing units – 19,116 (16,031 Single Family/3,085 Multi-Family)

KEY ELEVATIONS (Feet)

Pressure Zone A – 7,260
Pressure Zone B – 7,137
Pressure Zone A+ (RR Springs) – 7,320
Upper Lake Mary Spillway – 6,835.5 (USGS OFR 2008-1098)

Inner Basin cabin -9,415
Lake Mary WTP – 6,960
Wildcat Hill WRP – 6,760
Rio de Flag WRP – 6,860

18-2 Water Services Division Organizational Chart—7/2/2021



18-3 City of Flagstaff Water Rates and Fees**CITY OF FLAGSTAFF WATER & SEWER RATES**

Effective January 1, 2021 (**Subject to Change**)

MONTHLY FIXED CHARGE

Meter Size:	Customer Class	Inside City Rate	Outside City Rate
3/4"	All	\$ 16.64	\$ 18.30
1"	All	19.60	21.56
1 1/2"	All	26.98	29.68
2"	All	35.84	39.42
3"	All	56.52	62.17
4"	All	86.05	94.66
6"	All	159.88	175.87
8"	All	248.47	273.32
10"	All	351.83	387.01

WATER RATES

POTABLE WATER: (per 1,000 gallons)		Customer Class	Water Rate	Water Energy Rate	*WRIP FEE	Total Inside City Rate	Outside City Rate
Single Family	Tier 1 (0 - 3,500 gallons)	R1 or R4	\$ 3.44	\$ 0.66	\$ 0.52	\$ 4.62	\$ 5.08
Multi-Family Units	Tier 2 (3,501 - 6,200 gallons)		4.45	\$ 0.66	0.52	\$ 5.63	6.19
	Tier 3 (6,201 - 11,500 gallons)		6.86	\$ 0.66	0.52	\$ 8.04	8.84
	Tier 4 (11,501+ gallons)		13.72	\$ 0.66	0.52	\$ 14.90	16.39
		R2 or R3	4.42	\$ 0.66	0.52	\$ 5.60	6.16
Commercial/Schools		C	4.69	\$ 0.66	0.52	\$ 5.87	6.46
Northern Arizona University		NA	4.30	\$ 0.66	0.52	\$ 5.48	N/A
Manufacturing		MN	4.63	\$ 0.66	0.52	\$ 5.81	6.39
Landscaping/Lawn Meters		LM	4.69	\$ 0.66	0.52	\$ 5.87	6.46
Hydrant Meter		HM	7.17	\$ 0.66	0.52	\$ 8.35	N/A
Standpipe*		SP	7.17	\$ 0.66	0.52	\$ 8.3500	N/A

*Includes sales tax and environmental fee

*Effective 8/1/20

RECLAIMED WATER: (per 1,000 gallons)		Customer Class	Inside City Rate	Outside City Rate
Private Residential	Tier 1 (0 - 3,500 gallons)	R1	\$ 1.43	\$ 1.57
	Tier 2 (3,501 - 6,200 gallons)		1.77	1.95
	Tier 3 (6,201 - 11,500 gallons)		2.56	2.82
	Tier 4 (11,501+ gallons)		4.80	5.28
Commercial (no main Ext):		C	1.95	2.15
Commercial (w/ main Ext):		C	4.14	4.55
Manufacturing (no main Ext):		MN	1.93	2.12
Manufacturing (w/ main Ext):		MN	4.10	4.51
NAU (No main extension):		NA	1.82	N/A
NAU (with main extension):		NA	3.85	N/A
City Departmental		MU	1.95	N/A
Hydrant Meter		WR	4.00	N/A
Standpipe**		RS	4.0000	N/A
Off Peak/Golf Course:	Tier 1 (0 - 150,000,000 gallons)	WR	1.65	1.82
	Tier 2 (150,000,001+ gallons)	WR	1.65	1.82

**Includes sales tax and environmental fee

18-3 City of Flagstaff Water Rates and Fees, continued

SEWER RATES			
SEWER: (per 1,000 gallons)	Customer Class	Inside City Rate	Outside City Rate
Residential			
Single- and Multi-Family	R1 - R4	\$ 5.35	\$ 5.89
Non-Residential			
Car Washes	CW	5.38	5.92
Laundromats	L	5.53	6.08
Commercial	C	5.68	6.25
Hotels & Motels	H	7.58	8.34
Restaurants	RF	9.09	10.00
Industrial Laundries	IL	8.36	9.20
Manufacturing	MN	6.09	6.70
Pet Food Manufacturers	PF	13.34	14.67
Soft Drink Bottling	SD	10.57	11.63
Ice Cream Cone Manufacturing	IC	16.48	18.13
NAU	NA	4.91	5.40

STORMWATER RATE			
STORMWATER: (per ERU)	Customer Class	Inside City Rate	Outside City Rate
1 ERU (January 1, 2019 through June 30, 2019)	All	\$ 2.26	\$ 2.49
1 ERU (Effective July 1, 2019)	All	\$ 3.74	\$ 4.11

TRASH AND RECYCLING			
EFFECTIVE JANUARY 4, 2021			
RESIDENTIAL	Customer Class	Inside City Rate*	Outside City Rate*
One Trash and One Recycling Container (Each Container Serviced 1x per Week)	R1 - R4	\$ 22.03	24.23
Each Additional Container		10.00	11.00
COMMERCIAL	Customer Class	Inside City Rate*	Outside City Rate*
Container Size and Scheduled Pickup May Vary	Please call (928) 213-2110		

PRIVATE FIRE PROTECTION			
CONNECTION SIZE	Customer Class	Inside City Rate	Outside City Rate
4"	KS	\$ 12.59	\$ 13.85
6"		36.58	40.24
8"		77.96	85.76

ENVIRONMENTAL FEE EFFECTIVE 8/1/2020			
Percentage of core service charges- trash, water, recycling, stormwater, sewer, standpipe-potable/reclaimed	ALL	0.035	

18-3 City of Flagstaff Water Rates and Fees, continued

CITY OF FLAGSTAFF WATER & SEWER SYSTEM FEES						
Effective July 1, 2019 except as otherwise noted ("Subject to Change")						
WATER AND SEWER FEES						
All Single Family Subdivisions: Residential and Townhomes (1 Meter, 1 Unit) EXCEPT as listed in next section						
Any Meter Larger than a 3/4" Must have documentation approved by Water Services 928-213-2400						
Meter Size	Meter Fee	Water Capacity Fee	Sewer Capacity Fee	Service Fee	Taxes	Total Fees
3/4"	\$ 340	\$ 5,728	\$ 3,723	\$ 24	\$ 33.42	\$ 9,848.42
1"	\$ 520	\$ 9,566	\$ 3,723	\$ 24	\$ 49.94	\$ 13,882.94
1 1/2"	\$ 920	\$ 19,074	\$ 3,723	\$ 24	\$ 86.67	\$ 23,827.67
2" or larger Call	Call	Call	Call	Call	Call	Call
Exceptions Single Family Residential Subdivisions (1 Meter, 1 Unit)						
Linwood Heights & Rock Ridge West (1" Meter Required)						
1"	\$ 520	\$ 9,566	\$ 3,723	\$ 24	\$ 49.94	\$ 13,882.94
Pine Canyon (1 1/2" Meter Required)						
1" *(See Comment Below)*	\$ 520	\$ 9,566	\$ 3,723	\$ 24	\$ 49.94	\$ 13,882.94
1 1/2"	\$ 920	\$ 19,074	\$ 3,723	\$ 24	\$ 86.67	\$ 23,827.67
** Meters <1 1/2" in Pine Canyon must be approved by the Fire Department as adequate to handle domestic & fire sprinkler system						
Multi-Family Residential, Condos, Mobile Homes (Sewer Fees are Per Unit) <i>Water Services Invoice Required 928-213-2400</i>						
Meter Size	Meter Fee	Water Capacity Fee	Sewer Capacity Fee	Service Fee	Taxes	Total Fees
3/4"	\$ 340	\$ 5,728	\$3,723 (Per Unit)		Based on # of Units	
1"	\$ 520	\$ 9,566	\$3,723 (Per Unit)		Based on # of Units	
1 1/2"	\$ 920	\$ 19,074	\$3,723 (Per Unit)		Based on # of Units	
2"	\$ 1,070	\$ 30,530	\$3,723 (Per Unit)		Based on # of Units	
3"	\$ 3,130	\$ 57,279	\$3,723 (Per Unit)		Based on # of Units	
4"	\$ 4,130	\$ 95,484	\$3,723 (Per Unit)		Based on # of Units	
6" or Larger			Call			
Commercial/Non-Residential <i>Water Services Invoice Required 928-213-2400</i>						
Meter Size	Meter Fee	Water Capacity Fee	Sewer Capacity Fee	Service Fee	Taxes	Total Fees
3/4"	\$ 340	\$ 5,728	\$ 3,723	\$ 24	\$ 33.42	\$ 9,848.42
1"	\$ 520	\$ 9,566	\$ 6,218	\$ 24	\$ 49.94	\$ 16,377.94
1 1/2"	\$ 920	\$ 19,074	\$ 12,399	\$ 24	\$ 86.67	\$ 32,503.67
2"	\$ 1,070	\$ 30,530	\$ 19,845	\$ 24	\$ 100.44	\$ 51,569.44
3"	\$ 3,130	\$ 57,279	\$ 37,233	\$ 24	\$ 289.57	\$ 97,955.57
4"	\$ 4,130	\$ 95,484	\$ 62,068	\$ 24	\$ 381.38	\$ 162,087.38
6"	\$ 6,130	\$ 190,910	\$ 124,099	\$ 24	\$ 565.00	\$ 321,728.00
8"	\$ 13,737	\$ 305,468	\$ 198,566	\$ 24	\$ 1,263.40	\$ 519,058.40
10" Call	Call	\$ 439,157	\$ 285,468	\$ 24	Call	Call
WATER AND SEWER SYSTEM CONNECTION FEES						
WATER FEES		Tap Size	Tap Fees	Taxes	Total Fees	
Water Service Line Connection to Main - Residential Only		Call the Water Services at 928-213-2400				
Fire and Wet Taps (Contractor excavates to water main)		3/4" to 2"	\$ 190	\$ 17.44	\$ 207.44	
		3" to 12"	\$ 310	\$ 28.46	\$ 338.46	
Additional tap, same time and parcel, any size		3/4" to 12"	\$ 125	\$ 11.48	\$ 136.48	
SEWER FEES		Tap Size	Tap Fees	Taxes	Total Fees	
Sewer Taps (Contractor excavates to sewer main)		All Sizes	\$ 275	\$ 25.25	\$ 300.25	
To determine if service line connections or if water and sewer taps are required, please contact Water Services at 928-213-2400						

18-4 Water Services Personnel Contact Information

CONTACTS

CUSTOMER SERVICE

211 W. Aspen 213-2231

WATER DISTRIBUTION

5401 E. Commerce 213-2444

VEHICLE SHOP

3200 W. Route 66 213-2180

WASTEWATER COLLECTION

5401 E. Commerce 213-2445

WAREHOUSE

5447 E. Commerce 213-2279

COMM DEVELOPMENT

211 W. Aspen 213-2600

LAKE MARY PLANT

4500 S. Lake Mary 774-0262/556-1266

WILDCAT HILL PLANT

2800 N. El Paso 526-2520

ENGINEERING

211 W. Aspen 213-2602

WATER SERVICES ADMIN

2323 N. Walgreen St. 213-2400

METER ROOM

211 W. Aspen 213-2244

LANDFILL

N. Hwy 89 527-1927

PARKS/THORPE PARK BLDG

Thorpe Rd. 213-2161

STREETS YARD OFFICE

3200 W. Route 66 213-2165

SOLID WASTE

3200 W. Route 66 213-2110

PUBLIC WORKS ADMIN

3200 W. Route 66 213-2100

COF MAIN LINE 213-2000

FAX 213-2409

WATER SERVICES

WATER SERVICES ADMIN (213-2400)

ADMIN FAX 213-2409

VACANT X 2420 814-2596

Mark Richardson X 2443 (928) 202-0666

Marion Lee X 2406

Debra Valencia X 2407

Lisa Deem X 2471

WATER SERVICES ENGINEERING

VACANT X 2410 606-3303

Jim Davis X 2411

Justin Emerick X 2437 607-2541

Vacant X 2408

LAKE MARY PLANT (774-0262/556-1266)

(FAX 556-1267) (Plant Cell 853-2183)

(853-1451 Maint.cell)

Brian Huntzinger 522-4407/213-2459

Taylor Prichard 213-2454

Lee Williams 213-2476

Ladd Steele 213-2477

Stuart Penoff

Danny Hickey 213-2453

Kristian Heckard

Tim Hourihan

James Holsten

Vacant 213-2456

REGULATORY COMPLIANCE

Steve Camp 213-2475

Krista Snow 213-2458

Laney Stevens 213-2451

Janice Hakala

Joshua Brown 213-2428

Jolene Montoya x2117 (607-6778)

Kurt Novy x2118 (853-6031)

Glenn Kuyper x2119 (853-5904)

WATER DISTRIBUTION (213-2444)

Patrick O'Connor (699-61740) /213-2444

Call Out Phone #1 853-6136

Tyler Boswell

Jason Hoyungowa

Richard Tsinnie

Adam Nelson

Jim Ellis

Matt Anaya

Jared Bohn

Randy Cody

Lucas Staires

Robert Cuning

Joseph Armijo

Chase Stoneberger

Jesse McKerracher

Juan Rubalcava

Greg Sidwell 699-3989 cell

STORMWATER

VACANT X 2473

VACANT X 2472

Ed Schenk X 2470 666-0458

Chris Palmer X 2474 814-6346

Doug Slover X 2478

Paul Wolf

CUST SERVICE (213-2231)

Rick Tadder X 2252

Jessica Huleatt X 2267

Krista Devine X 2246

Kim Burns X 2233

Nanci Thomas X 2236

Danielle Tiedeman X 2234

Rachel Johnson X 2223

Rhannon Thomas X 2242

Celeste Coupe X 2251

Sabrina James X 2238

Matt Scheide X 2244 699-1489

Bill Katlin X 2244

Scott Klotz X 2244

Wildine Rodriguez X 2244

Manny Sierra X 2244

WASTEWATER COLLECTIONS (213-2445)

Joe Almendarez 853-4876/213-2445 cell

Call Out Phone #2 607-8841

Lorne Sampson

William Atherton

Ralph Hernandez

Brian Smith

Jason Toback

Vacant

Vacant

RIO DE FLAG PLANT (X1110)

Address 600 Babbitt Dr. (556-1301/1303)

(Cell 853-4584) (Fax 556-1302)

Frederick Wright

Cory Mueller

Paul Adams

Shawn McKee

Timothy McGinnis

Ryan Urena

WILDCAT HILL PLANT (526-2520)

(FAX 526-3526) (Plant Cell 699-8659)

Jim Huchel (853-8715)

Troy Dagenhart

Bill Case

Scott Gede

Matthew Black

Kiley McCormack

Kyle Nelson

Septage Shack (527-1431)

WATER RESOURCES

Erin Young X 2405 (821-5952)

Tamara Lawless X 2404 (607-7674)

Mary Samar X 2403 (890-7339)

SCADA/GIS

Timothy Harrington

Corryn Smith

William Liebe

Lorne Cargill

